received 12/07/05 (119)

BECHTEL JACOBS
Bechtel Jacobs Company LLC

DOE Contract No. DE-AC05-03OR22980
Job. No. 23900
LTR-PAD/EP-AC-05-0086
November 29, 2005

Mr. William E. Murphie, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513

RECORD COPY

Dear Mr. Murphie:

DE-AC05-03OR22980: Transmittal— ***Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** **(DOE/OR/07-2211&D2)**

The subject document is enclosed for transmittal to the Commonwealth of Kentucky and United States Environmental Protection Agency (EPA), which includes comments received from the review of the D1 by the Commonwealth of Kentucky. Comments received from the EPA did not require modification of the document. Also enclosed is the comment response summary.

This Secondary Document will be submitted on December 2, 2005. It will be distributed consistent with the requirements for distribution of a D2 document. Suggested text is also enclosed for your use in developing the Department of Energy transmittal letter, which should be provided to Bryan Clayton of my staff by December 2 2005.

If you require further information, please contact Mr. Clayton at (270) 441-5412.

Sincerely,

Robert J. Giroir
Paducah Manager of Projects

I-04614-0018

RJG:BJC:amc

Enclosures (3): As stated

c/enc: R. H. Blumenfeld, PPPO/LEX
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DOE/OR/07-2211&D2
Secondary Document

Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

FOR PUBLIC RELEASE

05-018(E)/112805

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

DOE/OR/07-2211&D2
Secondary Document

Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—December 2005

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

by
Bechtel Jacobs Company LLC
managing the

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-03OR22980

05-018(E)/112805

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PREFACE

This *Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2211&D2, was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). In accordance with Section IV of the Federal Facility Agreement for the Paducah Gaseous Diffusion Plant (PGDP), this integrated technical document was developed to satisfy both CERCLA and RCRA corrective action requirements. It is noted that the phases of the investigation process are referenced by CERCLA terminology within this document to reduce the potential for confusion.

The *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2150&D2, focuses on reducing the concentration of trichloroethene (TCE) and other volatile organic compounds (VOCs) in soils down to the base of the shallow aquifer at the C-400 Building area, which has been identified as the major source of groundwater contamination by TCE and other VOCs at PGDP. This Characterization Plan for a Remedial Design Support Investigation directs a limited field investigation to refine the known areal and vertical extent of TCE and other VOC contamination at the south end of the C-400 Building area in order to optimize design of the remediation system.

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CONTENTS

FIGURES

TABLES

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ABBREVIATIONS AND ACRONYMS

bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	chain-of-custody
DCE	dichloroethene
DMIP	Data Management Implementation Plan
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPT	Direct Push Technology
DWRC	dual-wall reverse circulation
EPA	U.S. Environmental Protection Agency
ES&HP	Environmental, Safety, and Health Plan
ft	foot/feet
GC/MS	gas chromatograph/mass spectrometer
HSA	hollow stem auger
HU	hydrogeologic units
IRA	Interim Remedial Action
LCD	Lower Continental Deposits
MIP	Membrane Interface Probe
ND	not detected
Paducah OREIS	Paducah Oak Ridge Environmental Information System
PGDP	Paducah Gaseous Diffusion Plant
ppb	parts per billion
ppm	parts per million
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDSI	Remedial Design Support Investigation
RFD	Request for Disposal
RI	Remedial Investigation
RGA	Regional Gravel Aquifer
ROD	Record of Decision
SADA	Spatial Analysis and Decision Assistance
SWMU	solid waste management unit
TCA	trichloroethane
^{99}Tc	technetium-99
TCE	trichloroethene
UCRS	Upper Continental Recharge System
UF_6	uranium hexafluoride
UCD	Upper Continental Deposits
UCRS	Upper Continental Recharge System
USEC	United States Enrichment Corporation
VOC	volatile organic compound

VC	vinyl chloride
WAG	waste area grouping
WM/DP	Waste Management/Disposition Plan

EXECUTIVE SUMMARY

Elevated concentrations of volatile organic compounds (VOCs) in subsurface soils and groundwater indicate that dense nonaqueous-phase liquid (DNAPL) source areas exist within the Upper Continental Recharge System (UCRS) and the Regional Gravel Aquifer (RGA), southeast and southwest of the C-400 Building at the Paducah Gaseous Diffusion Plant. Trichloroethene (TCE) and its breakdown products are the primary VOCs present. The *Record of Decision for Interim Remedial Action for the Groundwater Operable Unit for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2150&D2/R2, documents the selection of electrical resistance heating as the Interim Remedial Action (IRA) and the need for a Remedial Design Support Investigation (RDSI). The purpose of the RDSI is to refine the known areal and vertical extent of the contamination in the C-400 Building area to determine optimum placement of the remediation system.

The *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR-07-1727&D2, identifies approximately 0.5 acres near the south end of the C-400 Building that has TCE in-soil concentrations of 10 parts per million (ppm) or greater. These TCE levels generally delimit areas of UCRS soils that were directly impacted by TCE spills and that will be addressed by the IRA. Although the location of the VOC contamination in the RGA in the C-400 area is generally defined, the exact locations of the DNAPL contamination remain uncertain. Additional characterization of the extent of high VOC levels in both the UCRS and RGA is required to optimize the design of the upcoming remedial action.

This Characterization Plan presents the basic strategies and procedures that will apply to fieldwork conducted as part of the RDSI and specifies use of a Membrane Interface Probe to provide real-time, qualitative characterization of VOC levels in the UCRS and RGA. The Characterization Plan evaluates existing data in relation to a conceptual model of the location of DNAPL zones at the south end of the C 400 Building and identifies 46 locations for soil borings to provide additional characterization of UCRS VOC levels and 29 locations for soil borings for additional characterization of RGA VOC levels.

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1. PROJECT DESCRIPTION

Elevated concentrations of the volatile organic compound (VOC), trichloroethene (TCE), and its breakdown products in subsurface soils indicate that dense nonaqueous-phase liquid (DNAPL) primary source areas exist within the Upper Continental Recharge System (UCRS) soils at the south end of the C-400 Building at the Paducah Gaseous Diffusion Plant (PGDP). The TCE concentrations detected in the Regional Gravel Aquifer (RGA) during the Waste Area Grouping 6 (WAG 6) Remedial Investigation (RI) (DOE 1999a), which included the area around the C-400 Building, indicated a maximum of 701,000 parts per billion (ppb) in groundwater (64% of the maximum solubility of TCE in water) southeast of the C-400 Building, suggesting that DNAPL has penetrated the RGA and is acting as a secondary source of groundwater contamination.

Consistent with the results of the Groundwater Operable Unit Feasibility Study and the subsequent successful Six-Phase Heating Treatability Study, the C-400 Record of Decision (ROD) (DOE 2004) focuses on reducing the concentration of TCE and other VOCs in the source soils in the UCRS and RGA at the C-400 Building area, which has been identified as the major source of groundwater contamination by TCE and other VOCs at the PGDP. This Interim Remedial Action (IRA) will use electrical resistance heating to reduce permanently the VOC contamination in the area of the C-400 Building. The ROD includes a Remedial Design Support Investigation (RDSI) to further determine areal and vertical extent of TCE and other VOC contamination in the C-400 Building area in order to optimize design of the remediation system.

This Characterization Plan addresses the first two steps of the RDSI, (1) to collect and review existing characterization data for soil and groundwater in the area of the south end of the C-400 Building and (2) to locate additional characterization boreholes to refine the conceptual model of the 3-dimensional extent of the DNAPL zone. The Remedial Design Subcontractor will complete the investigation in three steps; (1) collect data on VOC level(s) in the selected borehole locations; (2) integrate the characterization data of the RDSI with analyses of previous samples to define the lateral and vertical distribution of VOC contamination in the UCRS and RGA; and (3) design, plan, and implement the IRA, electrical resistance heating. Note that the RDSI characterization data will not be documented in an investigation report, but will be presented in the Remedial Action Work Plan to identify the areas to be treated as part of the IRA.

1.1 PURPOSE OF THE REMEDIAL DESIGN SUPPORT INVESTIGATION

The primary purpose of the RDSI is to provide additional detail of the subsurface contaminant distribution, thus focusing the IRA. Specifically, the goals of the RDSI and the impact of those goals are as follows:

- Refine the known lateral and vertical distribution of the high-concentration contamination zones of VOCs in the UCRS and RGA (impacts the number and spacing of electrodes, as well as the geometry of the electrode grid);
- Assess the amount of VOC contamination present (impacts the anticipated treatment time and the technology to be selected to treat/destroy recovered VOCs);
- Identify the geometry of permeable zones in the UCRS (impacts vapor recovery design); and
- Characterize upgradient concentrations of VOCs in the RGA (impacts criteria selected to define the RGA DNAPL zone).

This characterization data will be screening level data that will not be utilized to develop risk or cleanup evaluations and, as such, will not be subject to the quality controls (QCs) necessary to perform those types of evaluations. The Remedial Action Work Plan will include the criteria to be met to discontinue electrical resistance heating.

1.2 SCOPE OF THE REMEDIAL DESIGN SUPPORT INVESTIGATION

The IRA of the C-400 ROD addresses the extent of the source of TCE and other VOCs in the soil of the UCRS and the RGA in the C-400 Building area. As known from the WAG 6 RI, the main source zone of TCE and VOCs is located in the southeast and southwest quadrants of the C-400 block. VOC contamination that may exist beneath the C-400 Building is beyond the range of this IRA.

This RDSI is intended to further refine the known extent of the source zone to determine the optimum placement and configuration of the remediation system. A Membrane Interface Probe (MIP) will provide near real time, qualitative characterization data. Characterization samples to define the baseline contaminant levels present at the start of electrical resistance heating will be collected during the follow-on construction phase of the IRA design.

2. SITE BACKGROUND

The PGDP (site EPA ID KY8890008982) is located in McCracken County in western Kentucky, about 6.5 kilometers (4 miles) south of the Ohio River and approximately 16 kilometers (10 miles) west of the city of Paducah. PGDP is a gaseous diffusion plant that has produced enriched uranium since 1952. Most industrial activities are sited in a 304-hectare (750 acre) security area and buffer zone that are restricted from access by the public. This secured area is located on 1457 hectares (3600 acres) controlled by the U. S. Department of Energy (DOE).

2.1 SITE DESCRIPTION, INFRASTRUCTURE, AND HISTORY

The C-400 Building is located near the center of the industrial section of PGDP. The building is bound by 10th and 11th Streets to the west and east, respectively, and by Virginia and Tennessee Avenues to the north and south, respectively. Figure 2.1 shows the location of C-400.

In general, the C-400 Building rests on a 16-in. concrete floor designed with four main pits/sumps and an east-side basement area. The east-side basement includes degreasing units, chemical cleaning tanks, and a plenum/fan room system to ventilate the building. Drawings and construction photographs suggest that the building floor overlies approximately 10 ft of gravel backfill. Floor drains found throughout the building emptied into interior and exterior building sumps or directly into storm sewer lines. (All floor drains have been sealed with epoxy and are no longer used.) Sumps for wastewater treatment and/or disposal are located northeast (Solid Waste Management Unit [SWMU] 40) and northwest (SWMU 203) of the C-400 Building.

Historically, some of the primary activities associated with the C-400 Building have been cleaning machinery parts, decontaminating the inside of used uranium hexafluoride cylinders, disassembling and testing of cascade components, and laundering plant clothes. The building also has housed various other activities, including recovery of precious metals and treatment of radiological waste streams.

In the area of the C-400 Building, the topography is relatively flat, with elevations ranging from approximately 370 to 376 ft above mean sea level. A thick concrete apron covers the heavy traffic area immediately south of the building, while gravel or asphalt covers the areas on the east and west sides of the building. A seldom-used railroad track serves the south side of the building where an overhead gantry crane and loading dock are present. Both the east and west sides contain an aboveground tank. Aboveground steam lines run along the west side of the building. Vehicle scales and aboveground steam lines are located immediately south of Tennessee Avenue.

Subsurface features around the building include storm sewers, underground piping running from storage tanks, and a variety of other buried utility lines (e.g., sanitary water and recirculating water mains, sanitary sewers, electrical ducts, communications lines, and grounding networks). Underground acid drain lines parallel the east and west sides of the C-400 Building.

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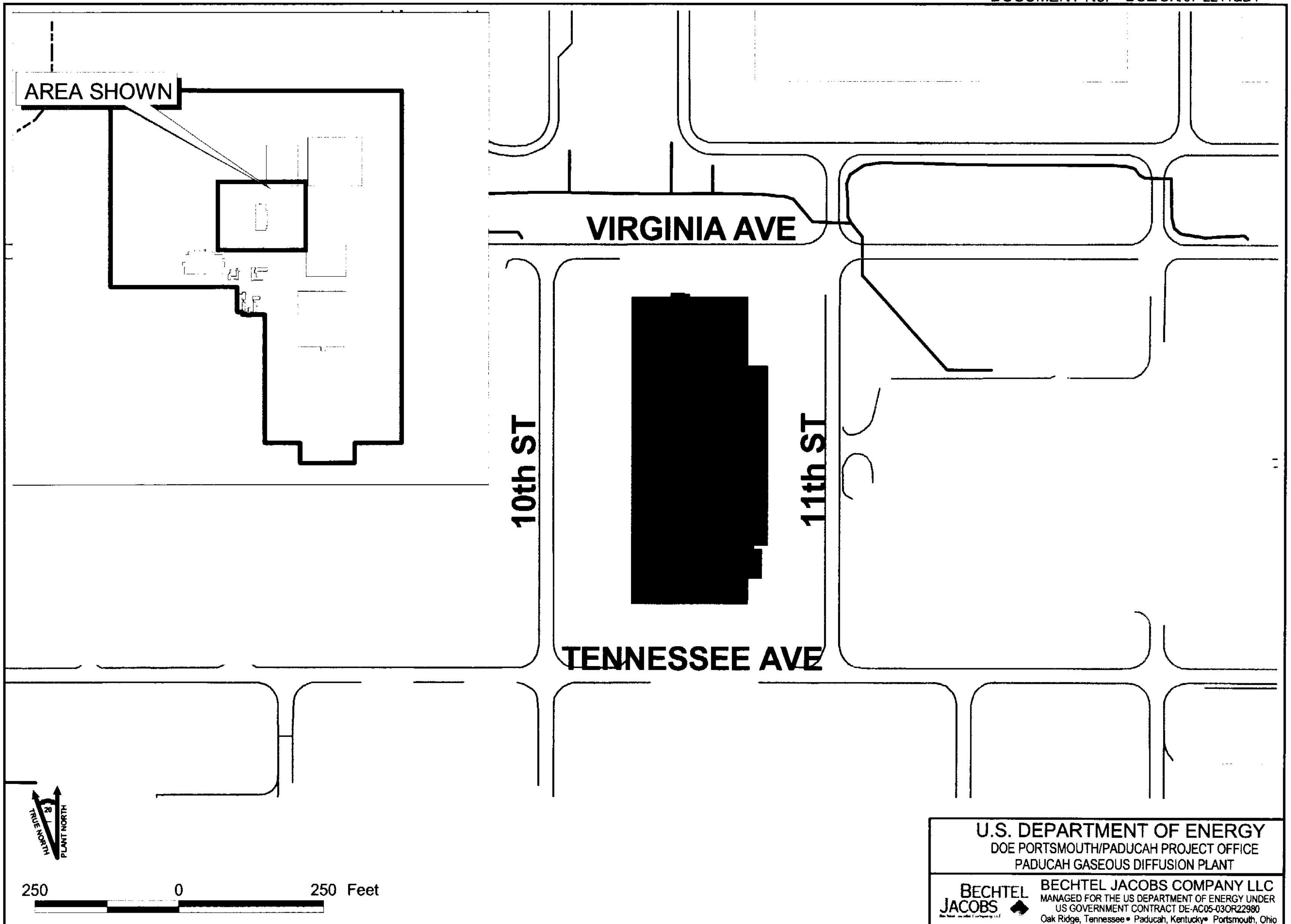

Fig. 2.1. Location of C-400.

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In June 1986, a routine construction excavation along the 11th Street storm sewer revealed TCE soil contamination. The cause of the contamination was determined to be a leak in a drain line from the C-400 Building's basement sump to the storm sewer. The area of contamination became known as the C-400 Trichloroethene Leak Site and was given the designation of SWMU 11. After the initial discovery of contamination, four borings were installed to better define the extent of the soil contamination. SWMU 11 and the C-400 Building area have been the subjects of several investigations since then.

Two actions have remediated some of the soil contamination near the southeast corner of C-400 Building. After the discovery of the C-400 Trichloroethene Leak Site in June 1986, some of the soils were excavated in an attempt to reduce the contamination in the area. Excavation was halted to prevent structural damage to the adjacent infrastructure, including a fence, TCE storage tank, and road. Approximately 310 ft^3 of TCE-contaminated soil was drummed for off-site disposal. The excavation was backfilled with clean soil, and the area was capped with a layer of clay. The 2003 Six-Phase Heating Treatability Study removed over 22,000 pounds of TCE (approximately 1900 gal) from the subsurface in a 43 ft-diameter treatment area in the southeast corner of the area near the C-400 Building (DOE 2003).

The southeast corner of the C-400 Building was the site of a treatability study using surfactants to chemically enhance the decontamination of the RGA during August 1994. Only one-third of the injected surfactant could be recovered, and there was no enhancement in the concentrations of TCE recovered from the extraction well. The test demonstrated that the selected surfactant was unsuitable for use as a solubilizer in the RGA.

PGDP's North-South Diversion Ditch historically conveyed some wastewater discharges of the C-400 Building, as well as rainfall runoff from the north-central area of PGDP, to Little Bayou Creek. DOE completed a cleanup of the on-site portions of the North-South Diversion Ditch in 2004 by excavating the uppermost contaminated sediments and placing a clay liner in the ditch channel, as well as constructing a surge basin to prevent future off-site releases of runoff from PGDP to off-site portions of the ditch.

Other proposed remedial actions for the C-400 area include the disassembly and disposal of the C-402 Lime House, including the in-place stabilization of the concrete basement and building slab. DOE anticipates a start of the decontamination and decommissioning project in 2006. The C-402 Lime House is located immediately east of the C-400 Building and was built in 1953 to provide lime slurry to a waste neutralization pit and to produce magnesium fluoride pellets. The building ceased operations prior to 1978.

2.2 PHYSICAL SETTING

This RDSI Characterization Plan focuses on refining the known extent of the DNAPL zone at the south end of the C-400 Building. Characterization data from the WAG 6 RI shows that the shallow DNAPL zone is limited primarily to the area bounded by 10th and 11th Streets, to the west and east, respectively, and Virginia Avenue, to the south, with "fingers" extending east of 11th Street and south of Virginia Avenue (Fig. 2.2). It appears likely that the deeper DNAPL zone, found in the RGA, extends east of 11th Street and may reach south of Virginia Avenue. The north limit of the DNAPL zone appears to be limited primarily to the SWMU 11 drain line.

2.3 SOILS

A sequence of clay, silt, sand, and gravel layers deposited on limestone bedrock underlies the C-400 area. The sediments above the limestone bedrock are grouped into three major stratigraphic units (loess, continental deposits, and McNairy Formation), based on how the sediments were deposited, and

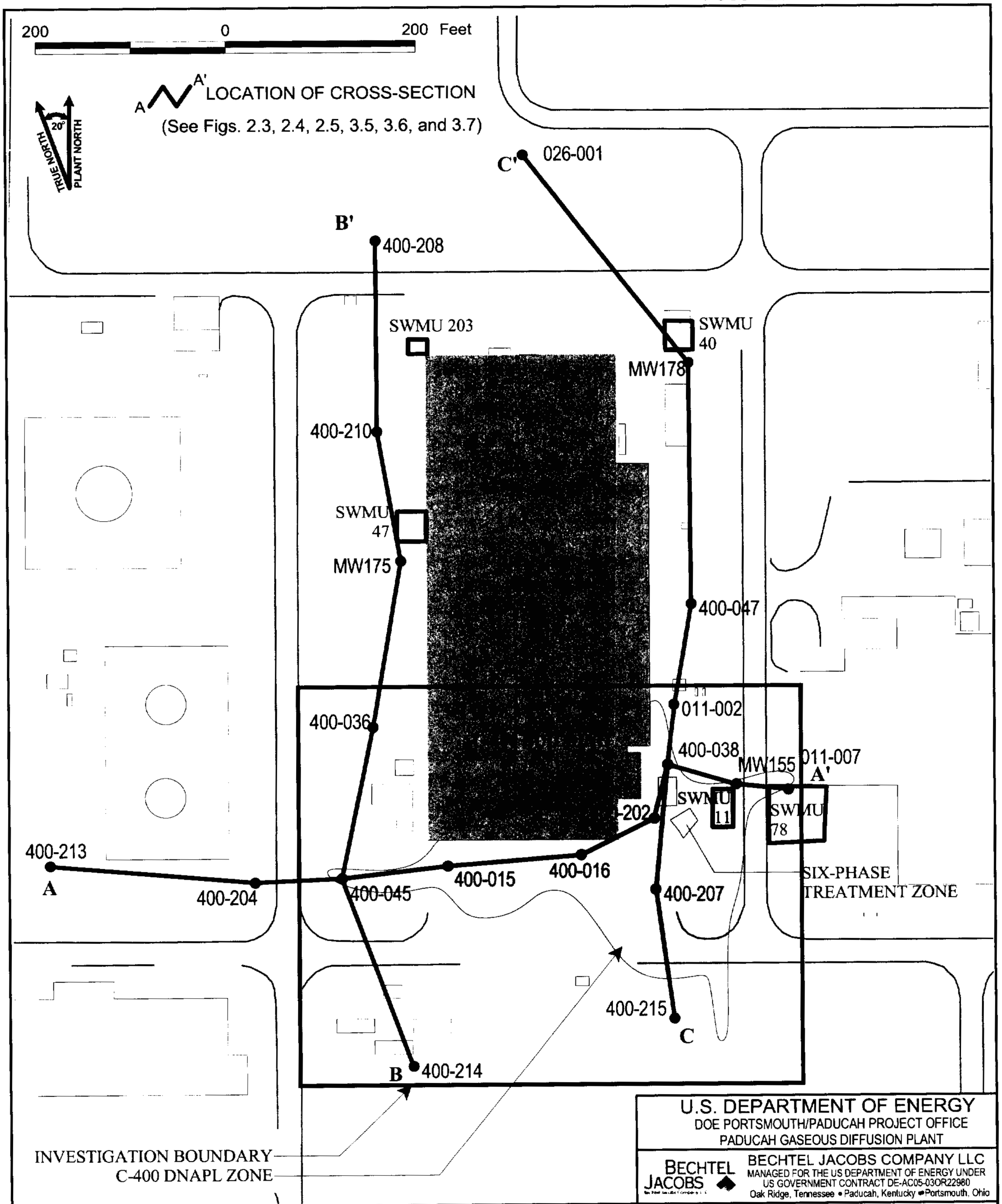

Fig. 2.2. Location of the C-400 DNAPL zone.

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three major hydrogeologic units (HUs) (the UCRS, the RGA, and the McNairy Flow System), based on how water moves within the sediments. The first (shallowest) stratigraphic unit consists of fill and a layer of wind-deposited, silty clay, or loess, extending from the surface to a depth of approximately 20 ft. Beneath the loess, the Upper Continental Deposits (UCD), a subunit of the continental deposits consisting of silt and clay interbedded with discontinuous sand and gravel layers, extends to an average depth of 55 ft below ground surface (bgs) (Figs. 2.3, 2.4, and 2.5).

The Lower Continental Deposits (LCD), also a subunit of the continental deposits, is a highly permeable layer of gravelly sand or chert gravel, typically extending from approximately 55 to 92 ft bgs below C-400 Building. Below the continental deposits is the McNairy Formation, a sequence of silts, clays, and fine sands that extends from approximately 92 to 350 ft bgs.

2.4 HYDROGEOLOGY

Shallow surface drainages parallel 10th and 11th Streets on the west and east sides of the C-400 Building. Most of the storm water from the C-400 Building area flows to storm drain inlets around the building and discharges via the storm sewer on the south side of the building to Outfall 008 and then to Bayou Creek on the west side of the plant.

The shallow groundwater system at the site, the UCRS, is subdivided into the HU1, HU2, and HU3 units and consists of loess (HU1) and the underlying UCD (HU2 and HU3). A 12- to 18-ft-thick silty or sandy clay interval, designated the HU3 aquitard, separates the sand and gravel lenses of the HU2 unit from the underlying RGA. The aquitard restricts the vertical flow of groundwater from the sands and gravels of the HU2 unit to the gravels of the RGA. In some limited areas, notably the southeast corner of C-400, the HU3 aquitard is considerably thinner and a lesser barrier to groundwater movement. The RGA, the uppermost aquifer in the C-400 area, consists primarily of the LCD stratigraphic unit. Below the RGA is the McNairy Flow System, which corresponds to the McNairy Formation. The uppermost portion of the McNairy Flow System typically is a clay or silty clay, which acts as an aquitard restricting groundwater flow between the RGA and McNairy Flow System.

The depth of the shallow water table (top of the UCRS) varies considerably across PGDP. In the C-400 area, ground covers and engineered drainage limit rainfall infiltration. The water table generally is encountered at depths of approximately 40 to 50 ft bgs. Water within the UCRS tends to flow downward to the RGA. Groundwater flow in the RGA generally is to the north, eventually discharging into the Ohio River and influent streams. At the C-400 area, groundwater flow is primarily to the northwest as part of the Northwest Plume, although there is evidence for some divergent flow to the east and possibly to the west, as part of the Northeast and Southwest Plumes, respectively.

2.5 CONTAMINANTS OF CONCERN FOR THE INTERIM REMEDIAL ACTION

This RDSI characterizes the extent of high concentrations of total VOCs in the soils underlying the south end of the C-400 Building. Sample analyses from the WAG 6 RI indicate that the primary site-related VOCs in subsurface soil and groundwater in the C-400 Building area are TCE and its breakdown products (*trans*-1,2-dichloroethene [DCE], *cis*-1,2-DCE, and vinyl chloride [VC]) and 1,1-DCE. Other VOCs found during the WAG 6 RI include tetrachloroethene, carbon tetrachloride, chloroform, 1,1,1-trichloroethane (TCA), 1,1,2-TCA, and toluene. Both the UCRS and the RGA contain high VOC concentrations. The following summarizes characteristics of the primary VOCs present in soils and groundwater in the C-400 Building area.

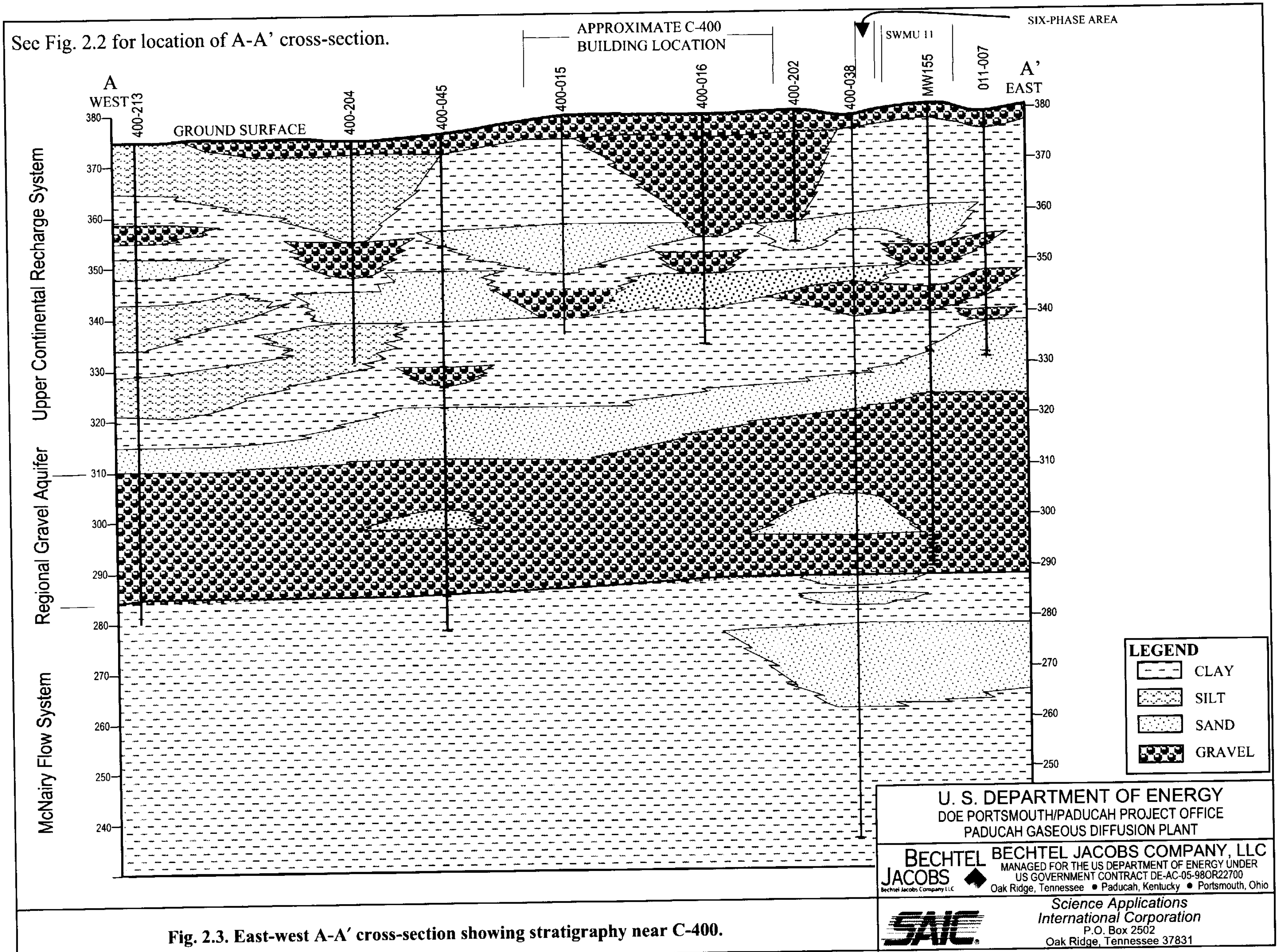

Fig. 2.3. East-west A-A′ cross-section showing stratigraphy near C-400.

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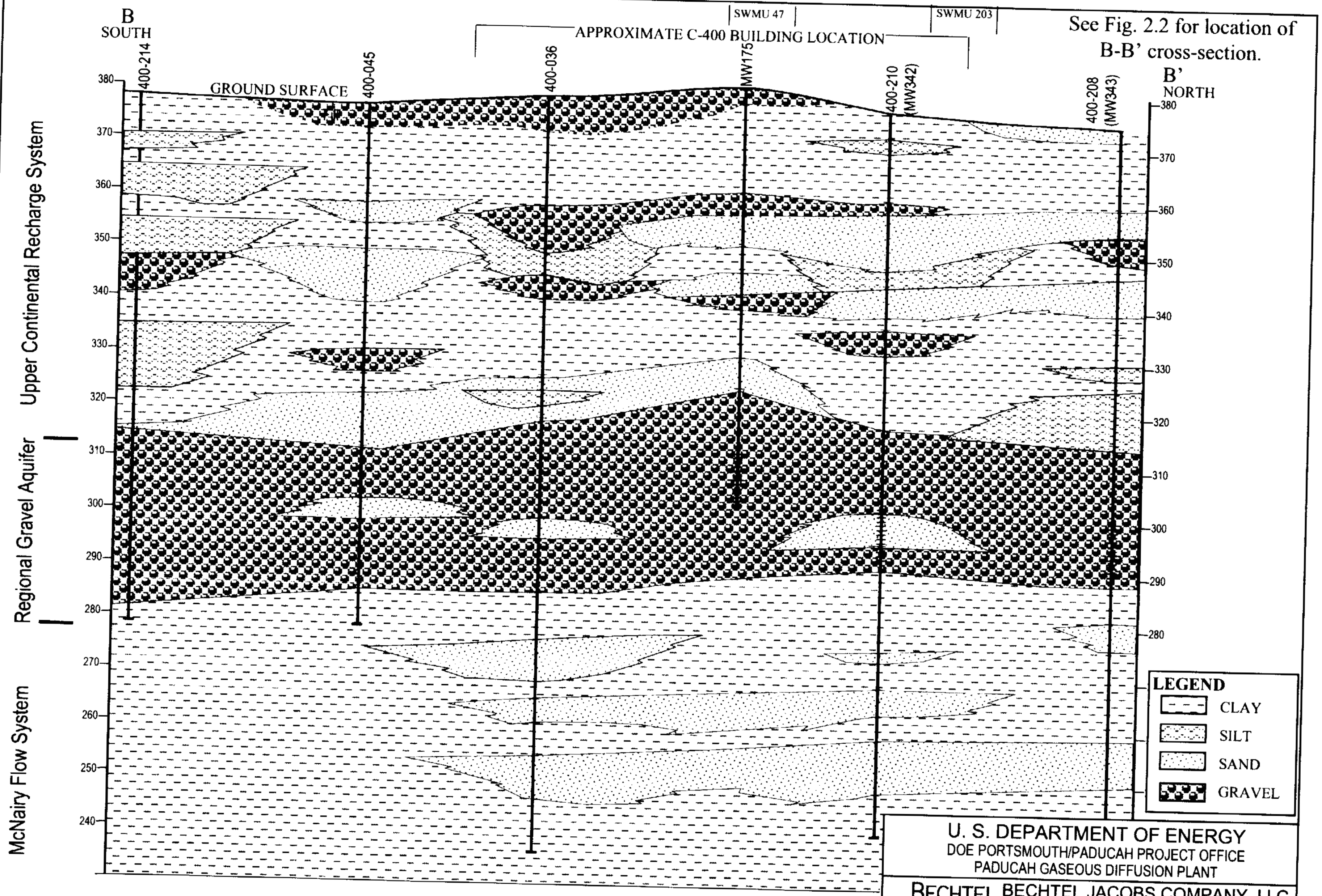

U. S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-98OR22700
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

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Oak Ridge, Tennessee 37831

Fig. 2.4. North-south B-B′ cross-section showing stratigraphy near C-400.

2-7

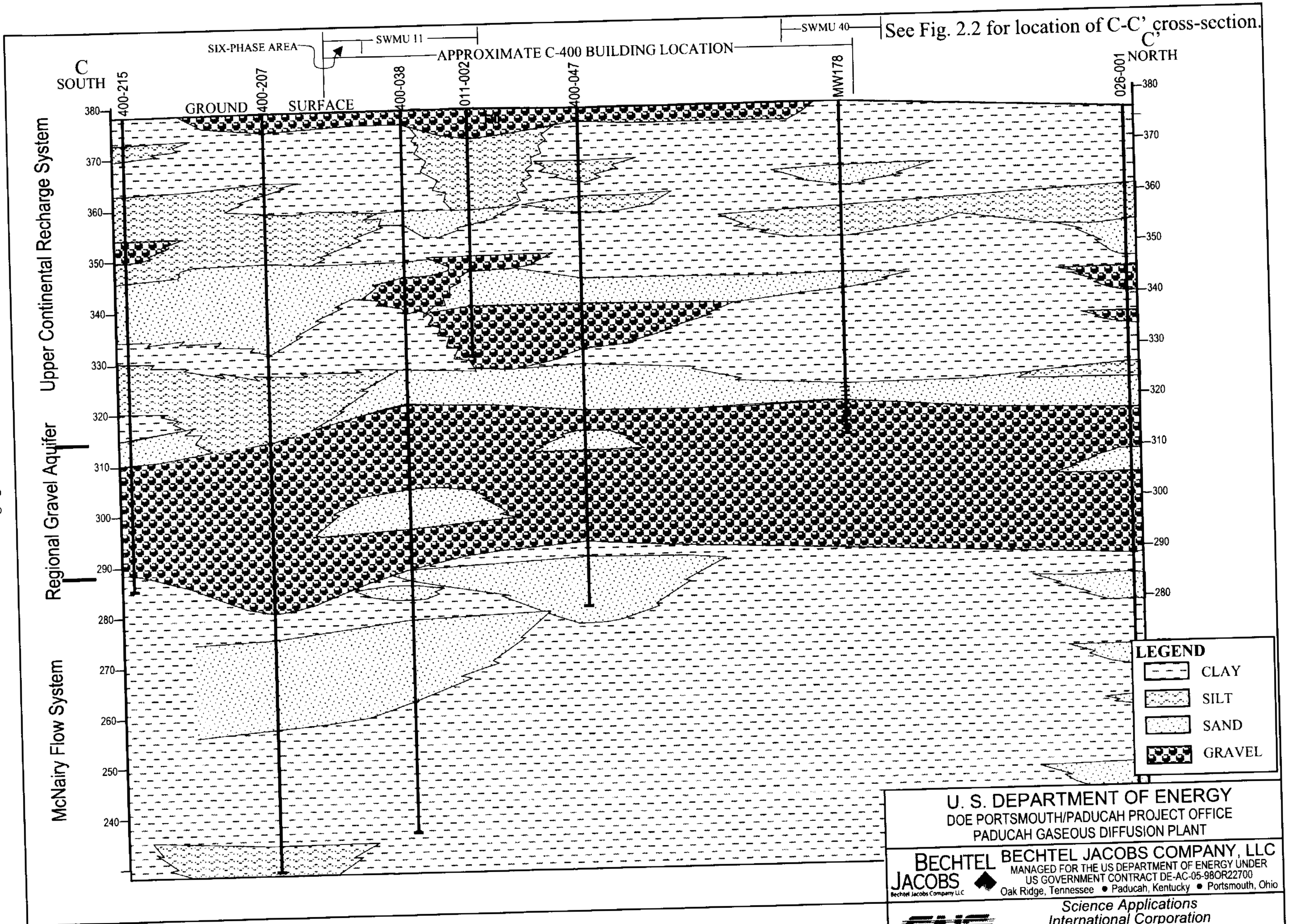

Fig. 2.5. North-south C-C′ cross-section showing stratigraphy near C-400.

TCE. TCE was the primary VOC detected in both subsurface soil and groundwater. This contaminant is a halogenated organic compound used by industry in the past for a variety of purposes. It was used mainly as a degreasing agent at the C-400 Building. Exposure to this compound has been associated with deleterious health effects in humans, including anemia, skin rashes, liver conditions, and urinary tract disorders. Based on laboratory studies, TCE is considered a probable human carcinogen. Over time, TCE naturally degrades to other organic compounds. TCE currently is not used at PGDP.

1,2-DCE, *cis-* and *trans-*. 1,2-DCE exists in two isomeric forms, *cis*-1,2-DCE and *trans*-1,2-DCE. Although not utilized extensively in industry, 1,2-DCE is used both in the production of other chlorinated solvents and as a solvent. Humans are exposed to 1,2-DCE primarily by inhalation, but exposure also can occur by oral and dermal routes. Information on the toxicity of 1,2-DCE in humans and animals is limited. Studies suggest that the liver is the primary target organ. The U.S. Environmental Protection Agency (EPA) does not classify 1,2-DCE as a human carcinogen.

VC. VC is a degradation product of TCE. It is also a halogenated organic compound and is used in industry as an intermediary of polyvinyl chloride (PVC) and other chlorinated compounds. VC has not been used in the PGDP manufacturing processes. Exposure to VC has been associated with narcosis and anesthesia (at very high concentrations), liver damage, skin disorders, vascular and blood disorders, and abnormalities in central nervous system and lung function. Liver cancer is the most common type of cancer linked with VC, a known human carcinogen. Other cancers related to exposure include those of the lung, brain, blood, and digestive tract.

1,1-DCE. 1,1-DCE is used primarily in the production of PVC copolymers and as an intermediate for synthesis of organic chemicals. Acute exposure to 1,1-DCE has been associated with central nervous system depression, which may progress to unconsciousness. 1,1-DCE is irritating when applied to the skin, and prolonged contact can cause first-degree burns. Direct contact with the eyes may cause conjunctivitis and transient corneal injury. EPA has classified 1,1-DCE as a possible human carcinogen.

The size and volume of the source zone comprised of TCE and other VOCs at C-400 Building area were estimated in the WAG 6 RI report. This information is sufficient to focus this RDSI Characterization Plan. Although the WAG 6 RI documented the presence of DNAPL in UCRS soil at the south end of the C-400 Building, the coarse nature of RGA soils prevented the collection of RGA soil samples that could be used to confirm the presence of a DNAPL comprised of TCE in the RGA. RGA water samples collected during the RI from the southeast and southwest sectors of the C-400 Building area, however, contained TCE concentrations suggestive of the presence of an RGA DNAPL source zone. In addition, a RGA water sample collected during the Six-Phase Heating Treatability Study (DOE 2003) from the suspected source zone contained DNAPL. Figures 2.6, 2.7, and 2.8 summarize the TCE levels observed in RGA groundwater in the C-400 Building area in the upper, middle and lower RGA, developed using data collected during the WAG 6 RI. Table 2.1 details high concentrations of TCE and other VOCs in the soil and groundwater that have been found in the southeast and southwest sectors of the C-400 Building area (Sectors 4 and 5, respectively, of the WAG 6 RI).

The TCE present in the soil and groundwater addressed by this IRA has originated from activities formerly conducted at PGDP. These activities included use of TCE as a degreaser and as a cleaning solvent. Spills of unused TCE also have been documented. Environmental media and debris contaminated with this spilled TCE may carry hazardous waste codes F001, F002, and U228 under Resource Conservation and Recovery Act (RCRA) guidelines.

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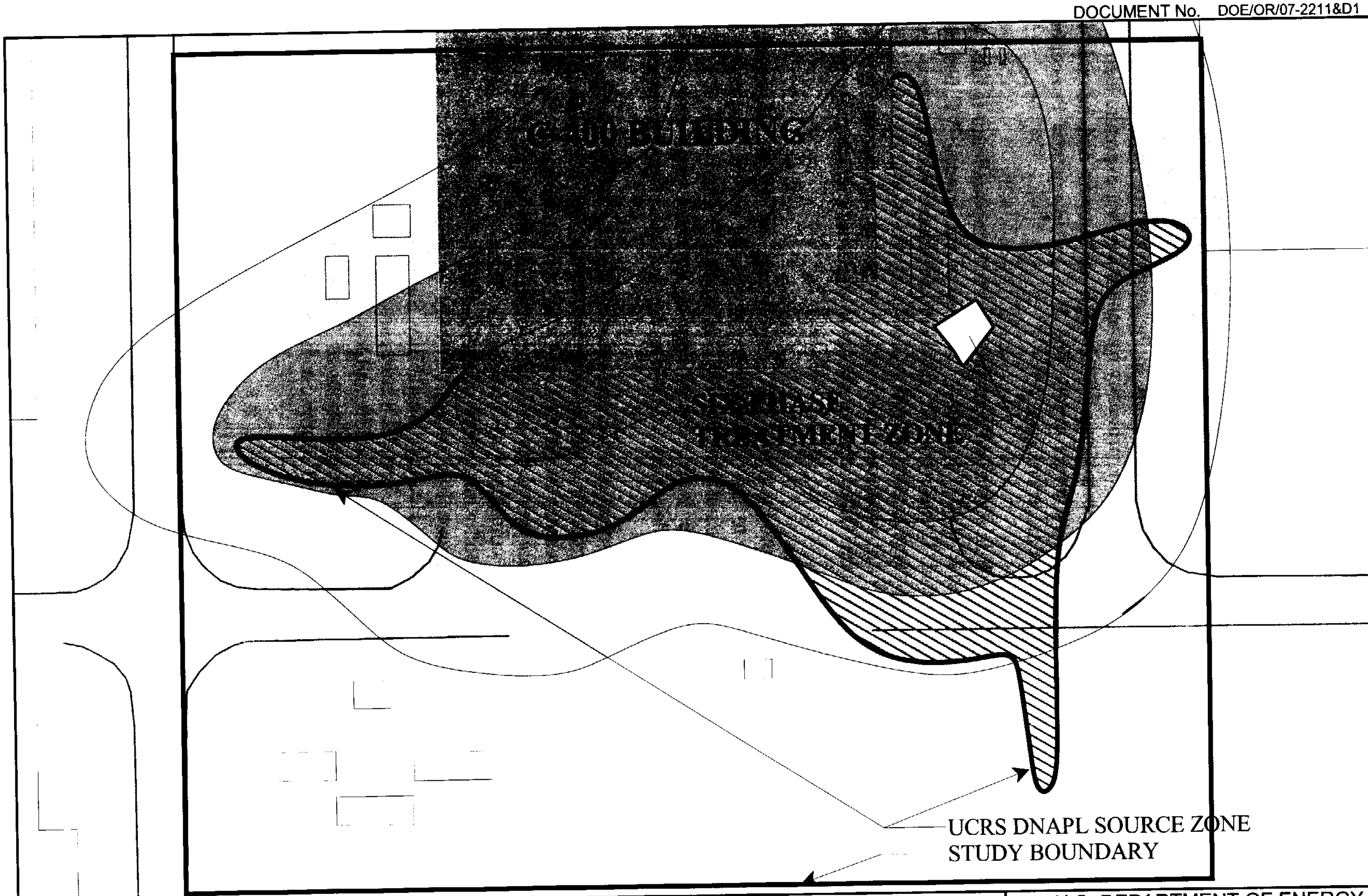

LEGEND

UCRS DNAPL SOURCE ZONE

STUDY BOUNDARY

TCE CONCENTRATIONS
as interpreted in DOE 2001

>100 mg/L
> 10 mg/L
> 1 mg/L

TRUE NORTH 2° PLANT NORTH

80 0 80 Feet

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

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Fig. 2.6. Upper RGA plume map.

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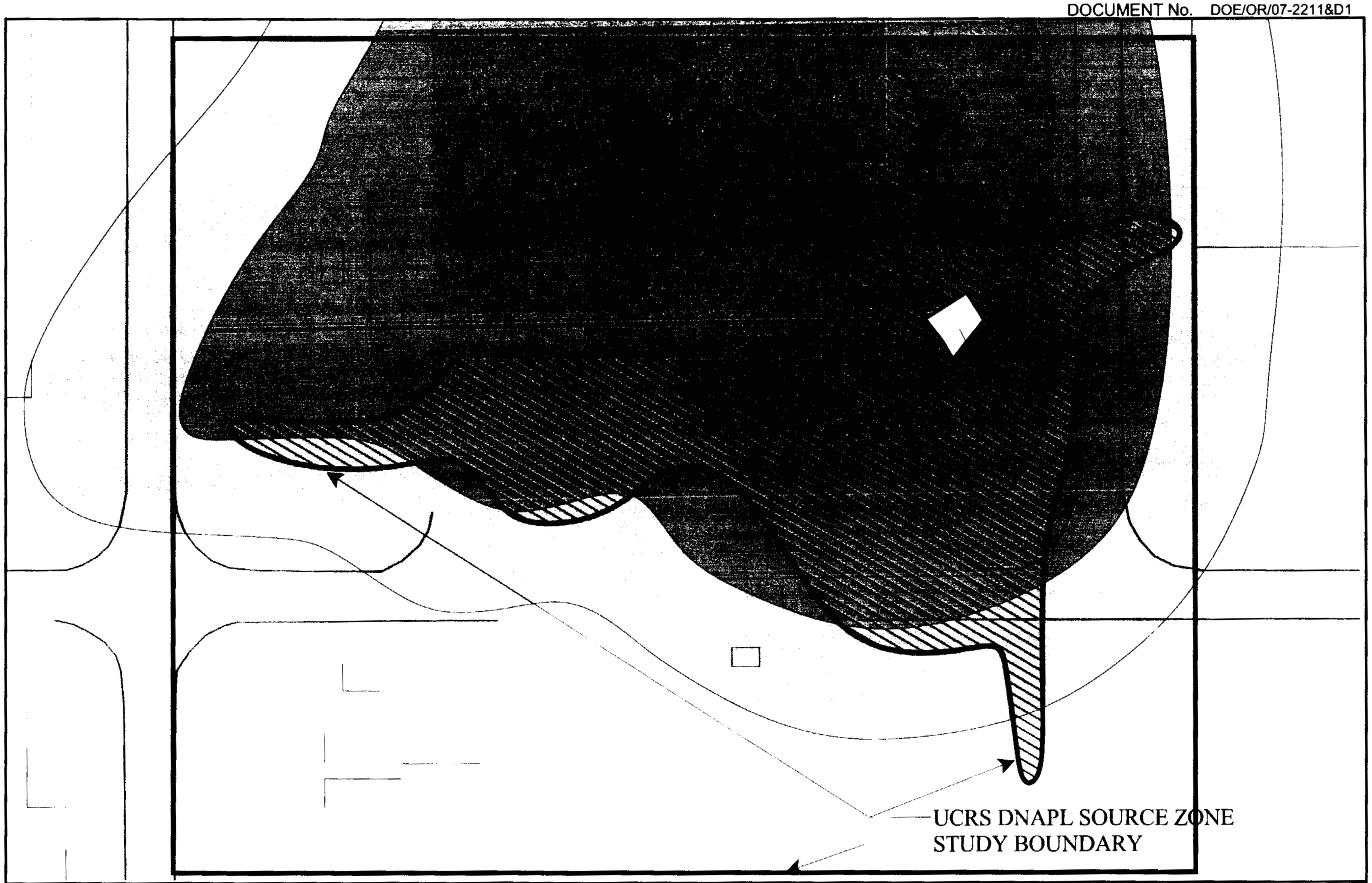

LEGEND

UCRS DNAPL SOURCE ZONE

STUDY BOUNDARY

TCE CONCENTRATIONS as interpreted in DOE 2001

>100 mg/L

> 10 mg/L

> 1 mg/L

80 0 80 Feet

TRUE NORTH PLANT NORTH

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

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Fig. 2.7. Middle RGA plume map.

FIGURE No. c5ac90001sk671_xsec.apr
DATE 04-26-05

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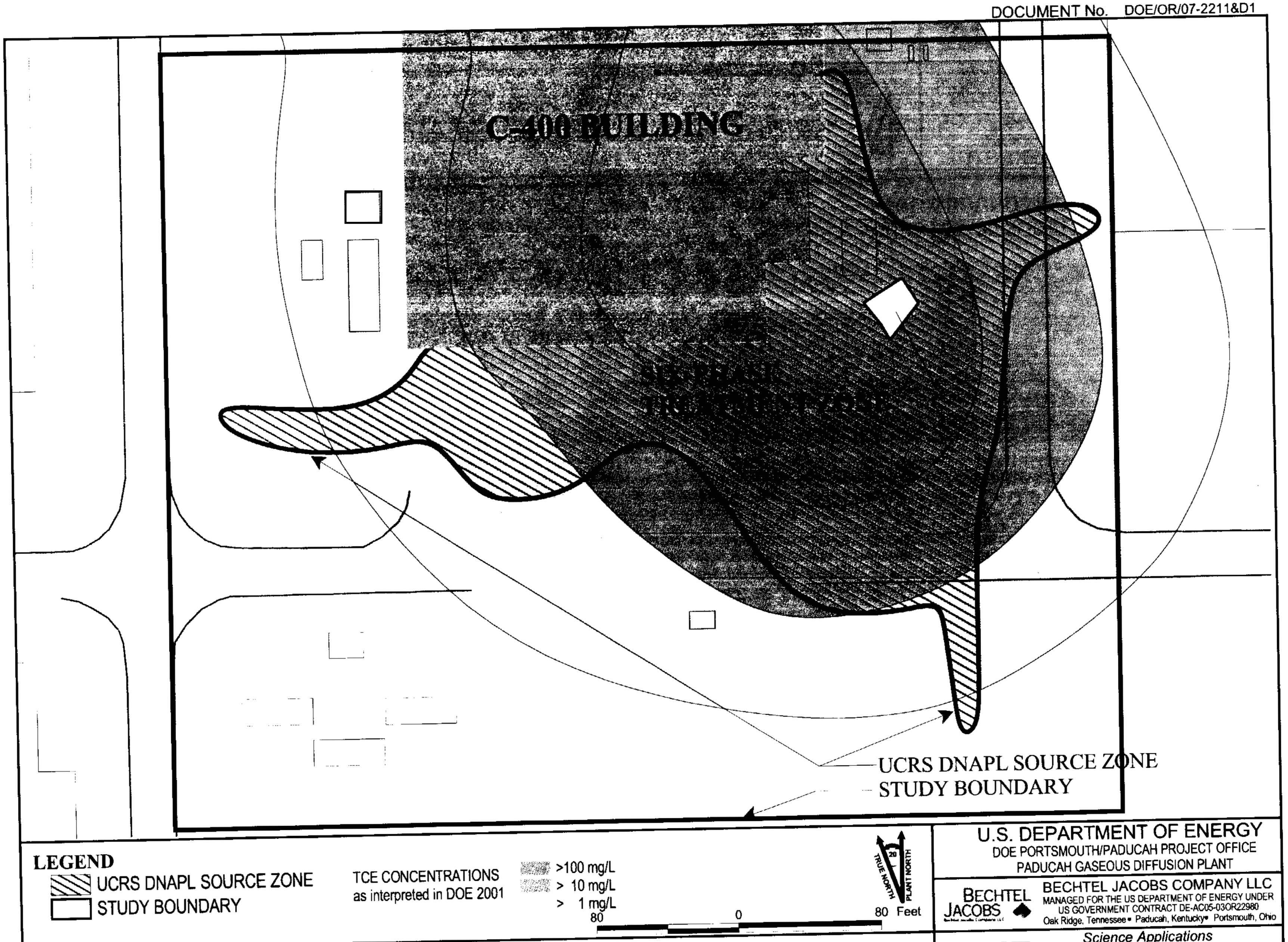

Fig. 2.8. Lower RGA plume map.

FIGURE No. c5ac90001sk671_xsec.apr
DATE 04-26-05

Table 2.1. Maximum concentrations of TCE and other VOCs[a] in soil and groundwater from the south end of the C-400 Building area

Contaminant	Contaminant levels (ppm) in soil		Contaminant levels (ppb) in water	
	Southeast sector (Sector 4)	Southwest sector (Sector 5)	Southeast sector (Sector 4)	Southwest sector (Sector 5)
TCE	11,055	168	2,374,000,000[1]	126,012
trans-1,2-DCE	102	15	1,200	53
VC	29	<1	133	8
cis-1,2-DCE	2	1	52,000	ND
1,1-DCE	<1	<1	154	5

[a] Data are from both the WAG 6 RI and the Six-Phase Heating Treatability Study.

ppm = parts per million
ppb = parts per billion
TCE = trichloroethene
DCE = dichloroethene
ND = not detected
VOC = volatile organic compound

2.6 SUMMARY OF PREVIOUS INVESTIGATIONS AT THE SITE

The Phase I and Phase II Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Site Investigations (CH2M HILL 1991, 1992) included the area around the C-400 Building with the installation of soil borings and groundwater wells. These investigations confirmed that TCE contamination at the southeast corner of the C-400 Building extended from the surface to the base of the RGA at 92 ft bgs. In 1995, the Phase IV Investigation demonstrated that the area around the C-400 Building was a potential major source for the Northwest Plume. Also in 1995, a review of C-400 Building process activities was completed and documented in *C-400 Process and Structure Review*, KY/ERWM-38, (MMES 1995).

In 1997, the WAG 6 RI focused on the area around the C-400 Building and further delineated contamination at SWMU 11. The RI identified the TCE transfer system at the southeast corner of the building (later named SWMU 533) as a significant source of soil and groundwater contamination. An additional area of soil contamination comprised of TCE and other VOCs and associated with a storm sewer was identified near the southwest corner of the building. The synthesis of the WAG 6 characterization data provides some definition of the lateral and vertical distribution of VOC contamination in the UCRS soils and RGA groundwater at C-400. In addition, the RGA data define the probable groundwater flow direction in the RGA. Results of the investigation are documented in the *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant*, DOE/OR/07-1727/V1&D2 (DOE 1999a).

Four treatability studies have been conducted to investigate methods for reducing or remediating the contamination comprised of TCE and other VOCs in the area near the C-400 Building. The first, using a surfactant, was conducted in 1994 near the southeast corner of the C-400 Building utilizing the existing monitoring wells. The results are reported in *The In-Situ Decontamination of Sand and Gravel Aquifers by Chemically Enhanced Solubilization of Multiple-Component DNAPLs with Surfactant Solutions* (Intera 1995). The next two studies were bench scale studies conducted as part of the WAG 6 RI. One looked at additional surfactants and co-solvents, while the other evaluated chemical oxidation. The results of these

---

[1] This is a sample of DNAPL. 1,000,000,000 ppb is the maximum possible concentration. The greater value of this analysis likely represents error introduced by calculations for projecting a whole sample analysis from results of analysis of a diluted sample (a required technique for very high concentration samples).

studies are documented in *Surfactant Enhanced Subsurface Remediation Treatability Study Report for the Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1999b) and in *Bench Scale In-Situ Chemical Oxidation Studies of Trichloroethene in Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1999c).

The fourth treatability study, conducted in 2003, was a pilot field test of electrical resistance heating, specifically the Six-Phase Heating technology, near the southeast corner of the C-400 Building. This study is reported in *Six-Phase Heating Treatability Study Final Report at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2003). Co-located soil samples and RGA groundwater samples, collected before and after the execution of Six-Phase Heating, documented the lateral and vertical distribution of VOC contamination in the UCRS and the RGA that was present within the Six-Phase Heating electrode array.

PGDP's groundwater monitoring program includes routine sampling and analysis of water from RGA wells in the C-400 area. These analyses support assessments of trends of the area VOC levels and the recent lateral and vertical distribution of the VOC contamination in the RGA around C-400.

3. REMEDIAL DESIGN SUPPORT INVESTIGATION PLANNING

A major element of this Characterization Plan is a Sampling Plan that optimizes boring locations to further characterize the VOC source zone at the south end of C-400. This Sampling Plan recognizes access restrictions due to overhead and underground utilities and other obstructions; however, successful implementation of this Sampling Plan will require close coordination with the DOE Prime Contractor and the United States Enrichment Corporation (USEC), operator of the PGDP. Several systems are in place to foster coordination, including an excavation/penetration permit program to address the presence of underground utilities (see Section 4.2), a hotwork/burn permit program to regulate spark and flame-producing operations, a lockout/tagout program to minimize the risk of contact with hazardous energy sources, an Unresolved Safety Question Determination (known as USQD) program to address nuclear criticality issues, and a radiation protection program to address radiological contamination and exposure monitoring. DOE and USEC cooperate in a Shared Site Program that coordinates the use of common areas and addresses impacts to leased areas for the DOE Contractors and Lessees.

3.1 KICK-OFF MEETING

A kick-off meeting January 11, 2005, defined the process of this Remedial Design and the scope of this RDSI. The primary role of this Characterization Plan is to review existing characterization data, develop a conceptual model of the extent of the DNAPL zone, and identify additional locations for characterization to further define the extent of the DNAPL zone. The Remedial Design Subcontractor will implement this Characterization Plan; integrate the characterization data derived from this investigation with the pre-existing soil and groundwater data for the area; and then design, construct, and implement the IRA, electrical resistance heating.

3.2 SITE WALK-DOWN

A site walk-down identified physical obstructions and other restrictions to access for the south C-400 area. This Characterization Plan anticipates that the Remedial Design Subcontractor will require site access for a small Direct Push Technology (DPT) rig to advance a MIP to a depth of approximately 60 ft and a standard-size drill rig to construct temporary boreholes to depths of approximately 100 ft as part of this investigation.

The walk-down was conducted on January 26, 2005, and addressed areas that are contiguous with 10th and 11th Streets and Virginia Avenue at the south end of the C-400 Building. The following are significant observations from the walk-down.

- Overhead power, telephone, and other utility lines are abundantly present. Main power lines parallel Virginia Avenue on the south side of the driveway for the scale house, 10th Street on the west side and 11th Street on the east side.

- The locale includes at least six different types of radiation areas (covering a significant percentage of the drill rig-accessible ground and pavement) that will limit access: DOE contamination area, DOE Radioactive Material Area, DOE Fixed Contamination Area, DOE Soil Contamination Area, USEC Radiation Area, and USEC Radioactive Materials Area.

- Large aboveground structures in the southeast corner of the C-400 block include the Six-Phase Heating Treatability Study fence, a TCE tank and adjacent sump, a loading dock, and a gantry crane. The IRA Subcontractor will remove these items as part of this action.

- The large aboveground structures in the southwest corner of the C-400 block include a nitric acid tank, autoclave, and steam and condensate pipelines.

- Aboveground pipelines parallel Virginia Avenue on the south side of the scale house driveway, as well.

- The area adjacent to the south side of the C-400 Building remains an active operations area, critical to continued operation of the plant. A thick concrete apron paves the south side of the C-400 Building and is used as a staging area for uranium hexafluoride (UF_6) cylinders. Large cylinder haulers routinely work in the area. Virginia Avenue and the concrete apron at the south end of C-400 are closed when the cylinder haulers are present. The staging area for UF_6 cylinders is a radiation area when cylinders are present.

- Trains seldom pass on the train tracks that run through the south end of the C-400 block.

- Trucks access the scale house on the south side of Virginia Avenue on a frequent basis.

- Underground utilities underlie much of the area at the south end of the C-400 Block. There was no indication of recent additions or relocations of buried utilities during the site walk-down.

Figure 3.1 illustrates the location of the main overhead obstructions that were observed during the site walk-down. Underground utilities in the south C-400 area are shown on Figure 3.2.

3.3 ACQUISITION AND EVALUATION OF EXISTING SITE DATA

The southeast and southwest sectors of the C-400 Building area, as defined for the WAG 6 RI, encompassed approximately 7.5 acres. Of this area, the RI identified approximately 0.5 acres total in the two sectors that had TCE in-soil concentrations of 10 ppm or greater in the UCRS. These TCE levels approximately delimit the areas of UCRS soils that were directly impacted by TCE spills and that will be addressed by this IRA. Although the location of the VOC contamination in the RGA in the C-400 area generally is defined, the exact locations of the DNAPL contamination remain uncertain.

The conceptual model of VOC DNAPL occurrence used in this RDSI Characterization Plan is based upon the existing VOC analyses of soil and groundwater in the proximity of the south end of the C-400 Building. Appendix C5 of *Feasibility Study for the Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001a) includes an analysis of the 3-dimensional distribution of TCE in the south C-400 area, as determined by the WAG 6 RI data. These interpretations form the basis for the conceptual model, but have been adjusted for the cleanup achieved in the area of the Six-Phase Heating Treatability Study.

It should be noted that most of the data used for the site conceptual model comes from soil and water samples of the WAG 6 RI, with fieldwork conducted in 1997. More recent data from the Six-Phase Heating Treatability Study represents conditions in 2003. Although these soil and water analyses are now several years old, DNAPLs are slow to dissolve, providing a steady source of dissolved contamination. Except for the vicinity of the Six-Phase Heating Treatability Study, the distribution of VOCs in soil and groundwater is not likely to have changed significantly since the WAG 6 RI.

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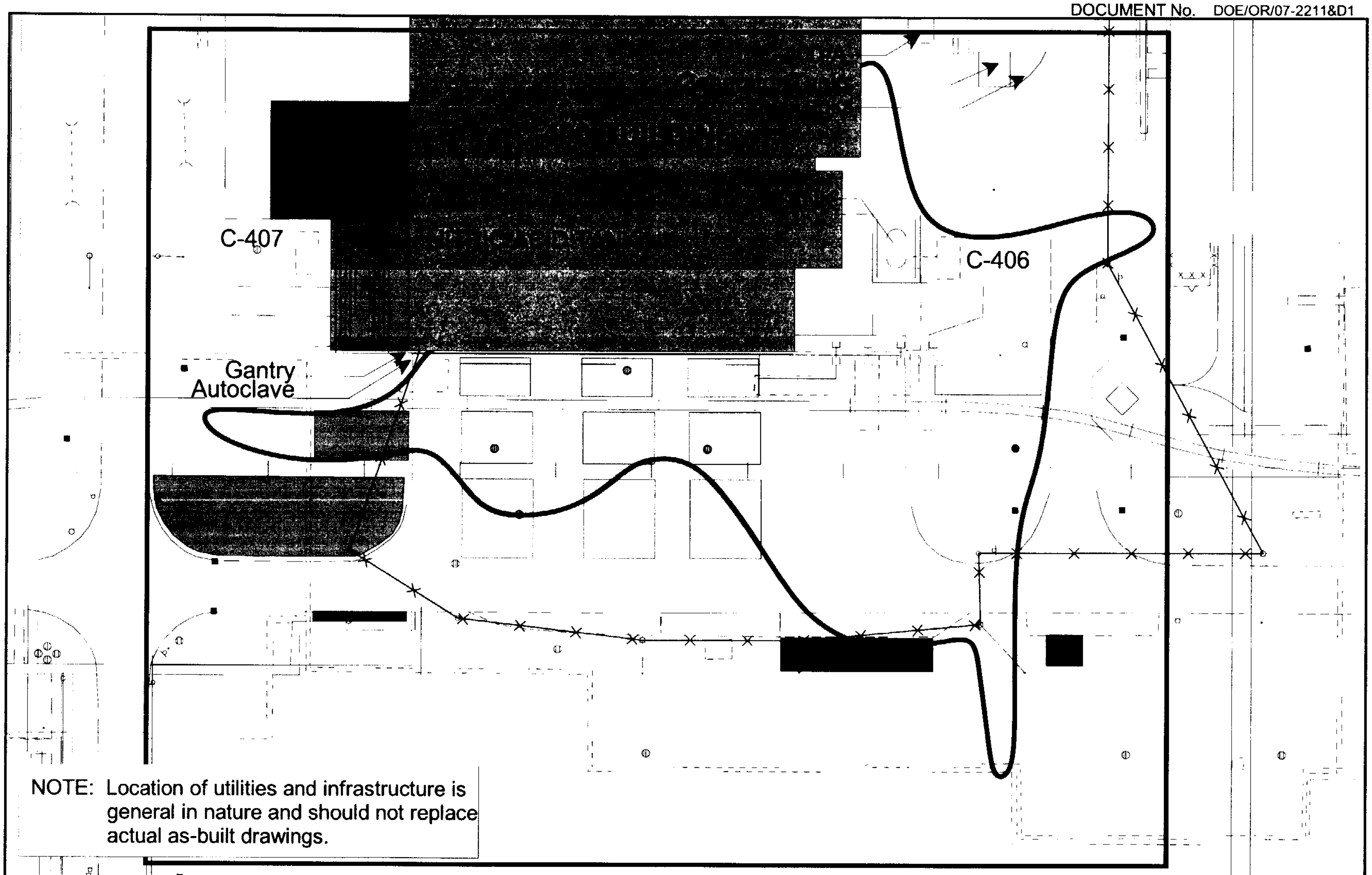

LEGEND

OVERHEAD ELECTRICAL LINE
DNAPL SOURCE ZONE
C-400 BUILDING

RADIOLOGICALLY POSTED AREAS

CONTAMINATION AREA
FIXED CONTAMINATION AREA
RADIATION AREA
RAD MATERIAL AREA
SOIL CONTAMINATION AREA

80 0 80 Feet

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Fig. 3.1. Aboveground obstructions in the south C-400 area.

FIGURE No. c5ac90001sk671R4.apr
DATE 03-02-05

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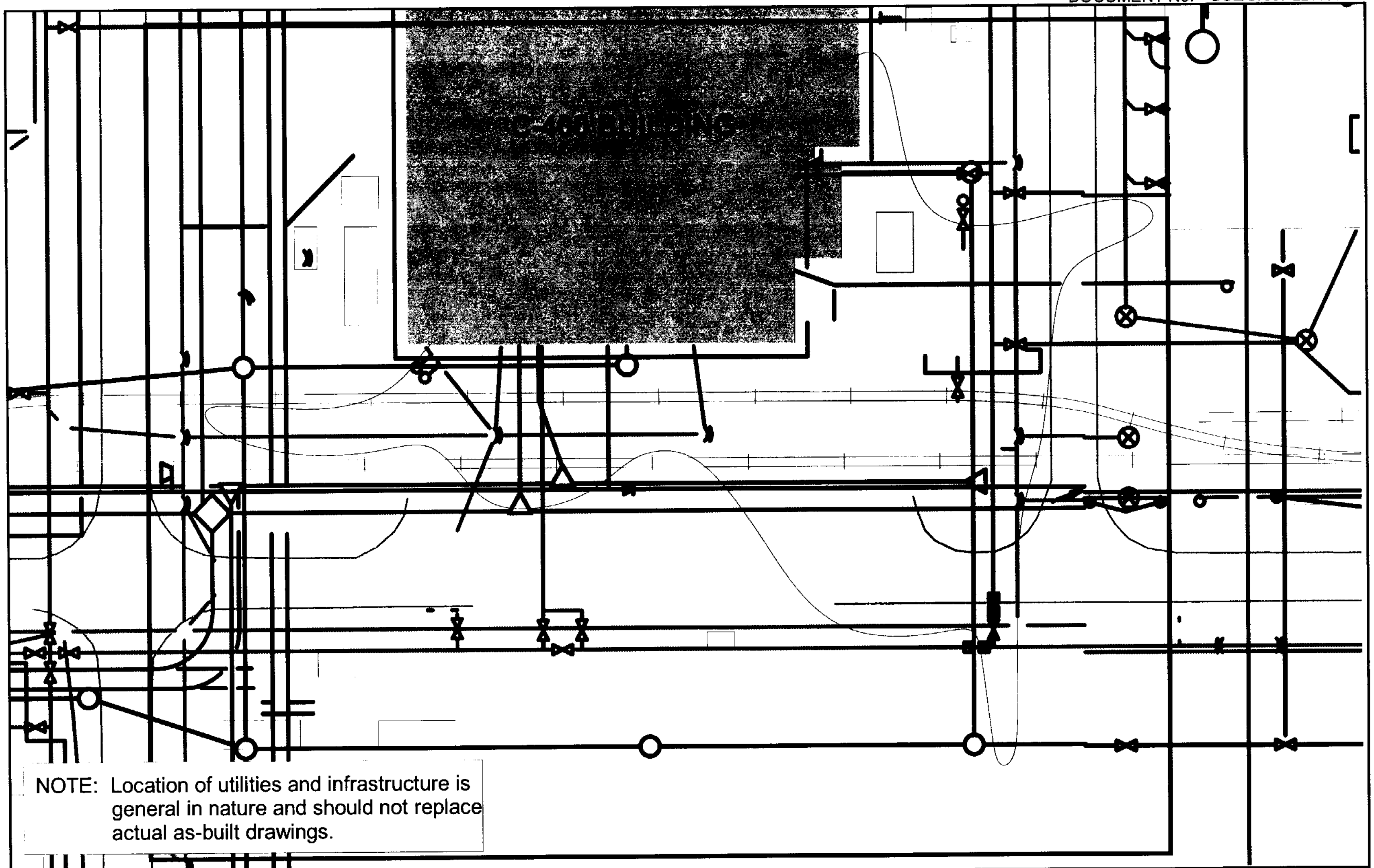

LEGEND

- ELECTRICAL UTILITY
- RECIRCULATING WATER UTILITY
- SANITARY WATER UTILITY
- SANITARY SEWER
- STORM SEWER
- DNAPL SOURCE ZONE

80 0 80 Feet

TRUE NORTH PLANT NORTH

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Fig. 3.2. Belowground obstructions in the south C-400 area.

FIGURE No. c5ac90001sk671R4.apr
DATE 03-02-05

The southeast C-400 Building area contains SWMU 11 and the TCE transfer pumps and piping. The southwest C-400 block includes an area of soil contamination that has not been linked to a particular C-400 Building process. Smaller, less significant areas of contamination of soil by TCE and other VOCs were identified on the east and west sides of the C-400 Building, as well as near the northwest corner of the building. The elevated concentrations of TCE and its breakdown products in subsurface soils suggest that DNAPL source areas comprised of VOCs, principally TCE, exist within the UCRS soils of the southeast and southwest sectors of the C-400 Building area.

The majority of DNAPL mass appears to be present in the southeast C-400 block, apparently resulting from spills at a former TCE transfer pump. High VOC levels in RGA groundwater in this area indicate that DNAPL has migrated to the base of the RGA. Another DNAPL zone, the C-400 TCE Leak Site (identified as SWMU 11), is located to the east, adjacent to 11th Street. The leak site arose from discharges to a storm sewer from a sump pump in the C-400 Building main degreaser area. A third DNAPL zone, occurring in the southwest C-400 block adjacent to the south end of the C-400 Building, appears to be associated with a storm drain. Trends in VOC levels in the RGA suggest that DNAPL penetrated to the upper RGA at the C-400 TCE Leak Site and at the DNAPL zone located in the southwest C-400 block.

All historical data used in the assessment of the south C-400 block were downloaded from Paducah's Oak Ridge Environmental Information System (Paducah OREIS). The software *Spatial Analysis and Decision Assistance (SADA)* (UTK 2002) was used to segregate the available soil and groundwater analyses for discrete depth intervals and to display the data for analysis. Figures 3.3 through 3.4 illustrate the soils VOC contamination in the south C-400 block as depth discrete "slices." Figures 3.5 through 3.7 present vertical cross sections of the same soils VOC contamination. (Refer to Fig. 2.2 for locations of the cross sections.)

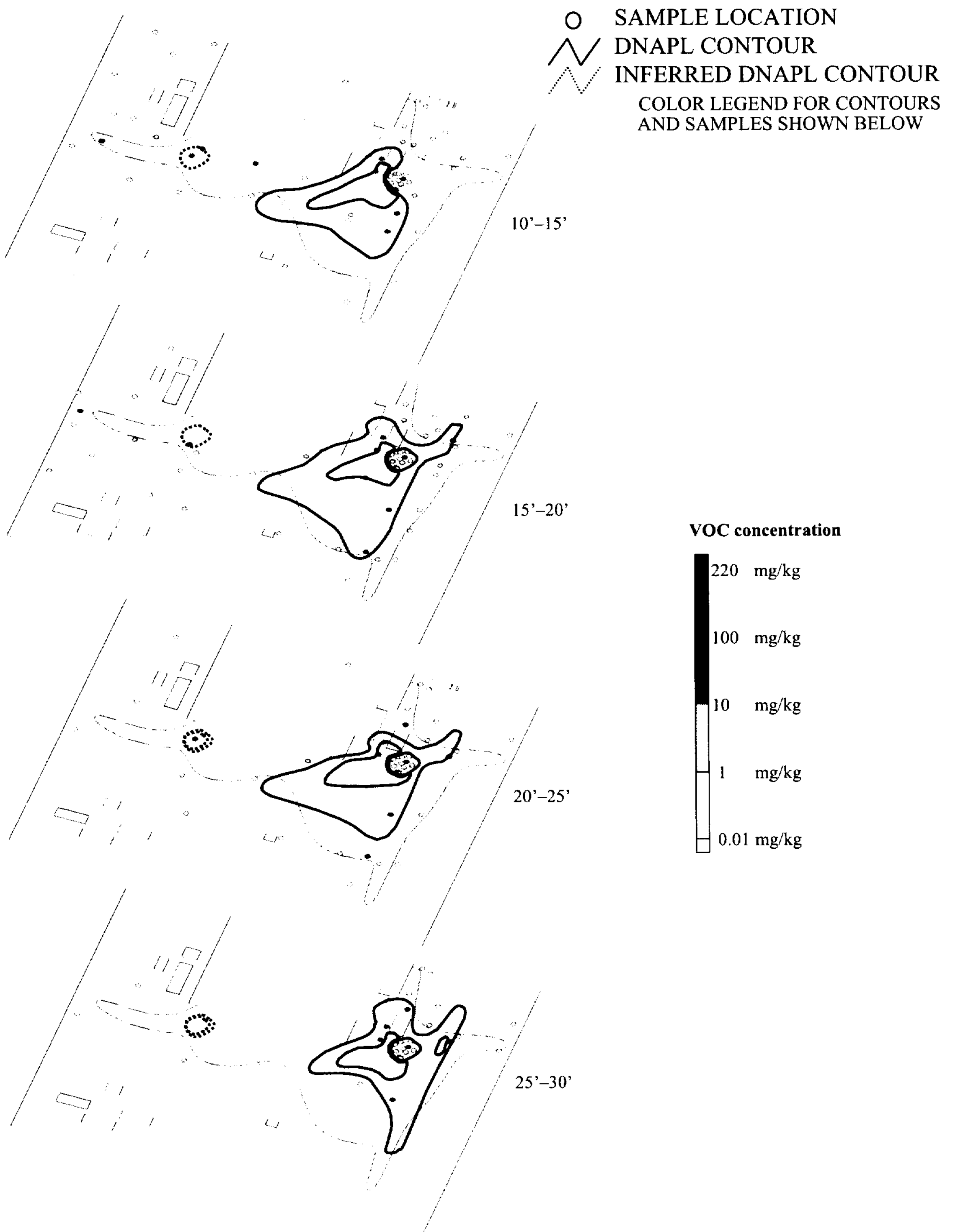

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Fig. 3.3. Upper UCRS DNAPL contours.

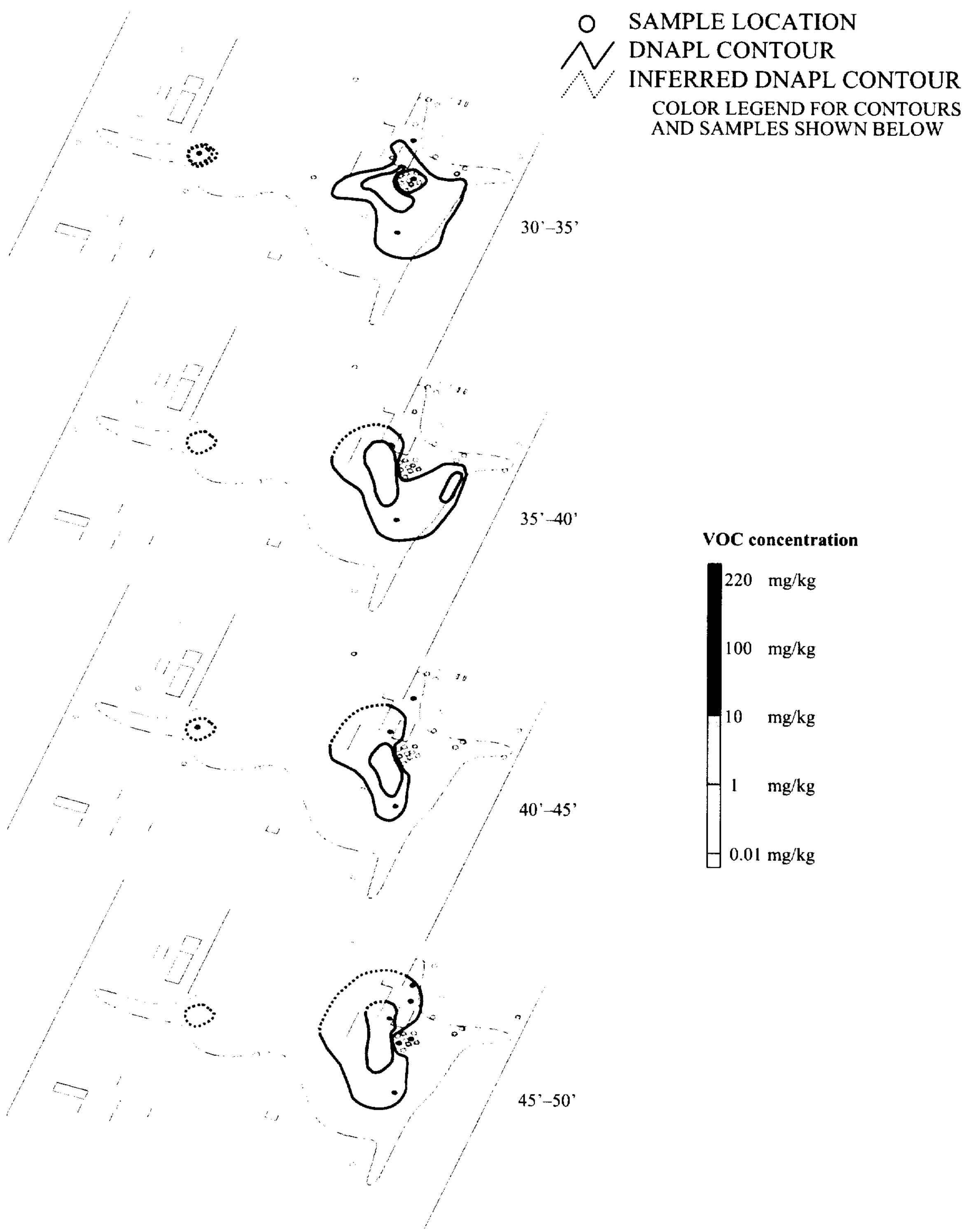

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Fig. 3.4. Lower UCRS DNAPL contours.

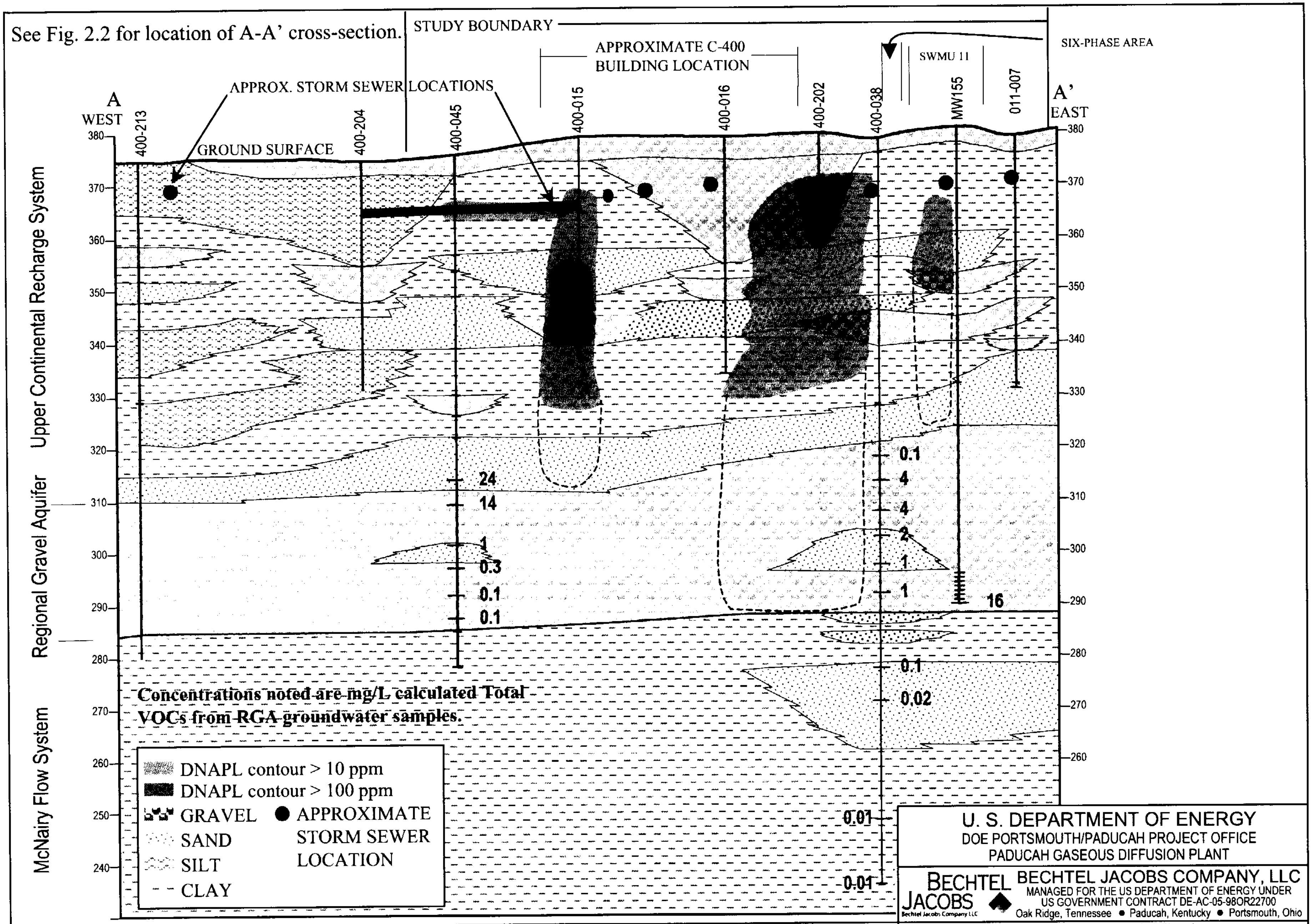

Fig. 3.5. East-west A-A′ cross-section showing VOC contamination near C-400.

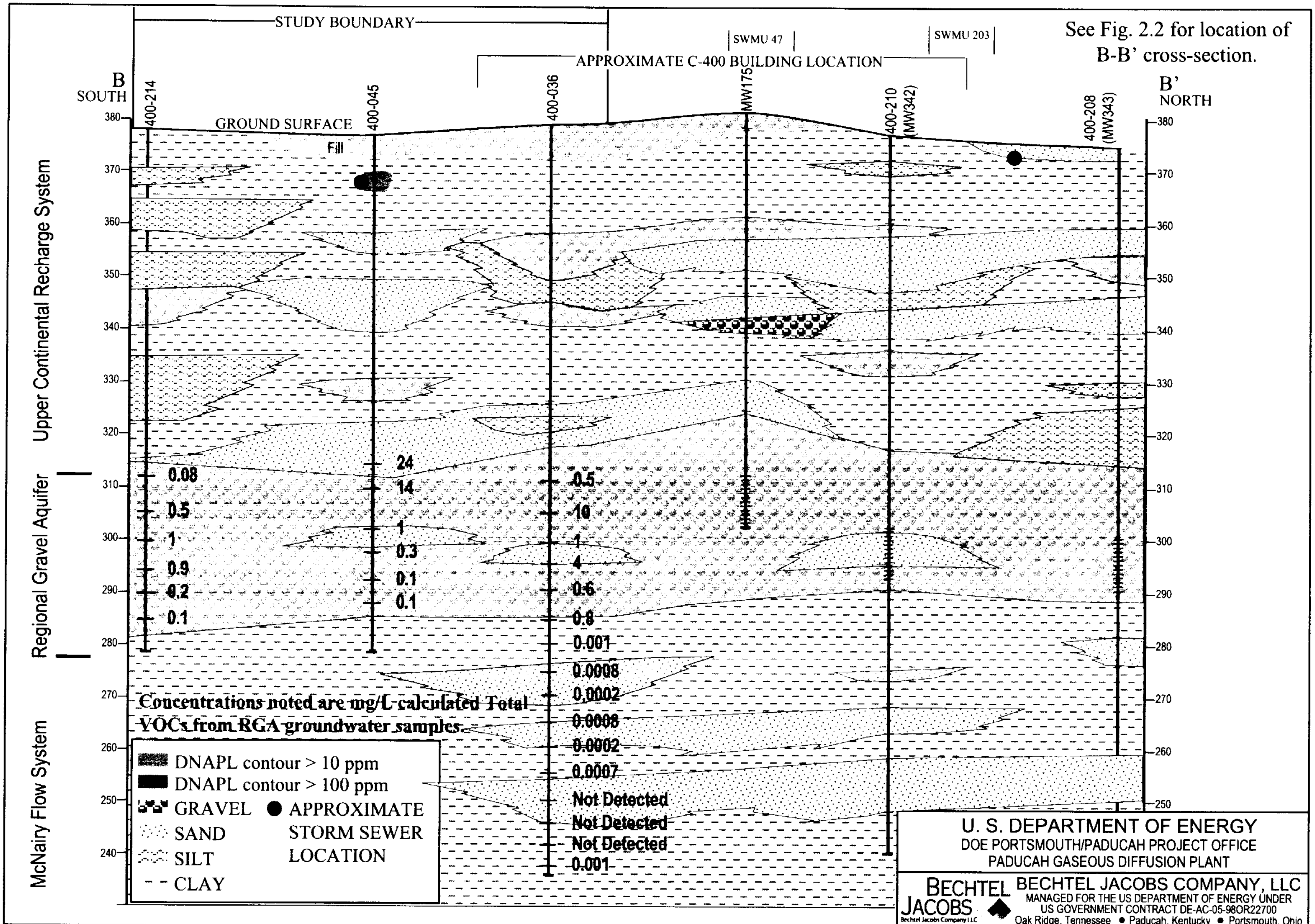

Fig. 3.6. North-south B-B′ cross-section showing VOC contamination near C-400.

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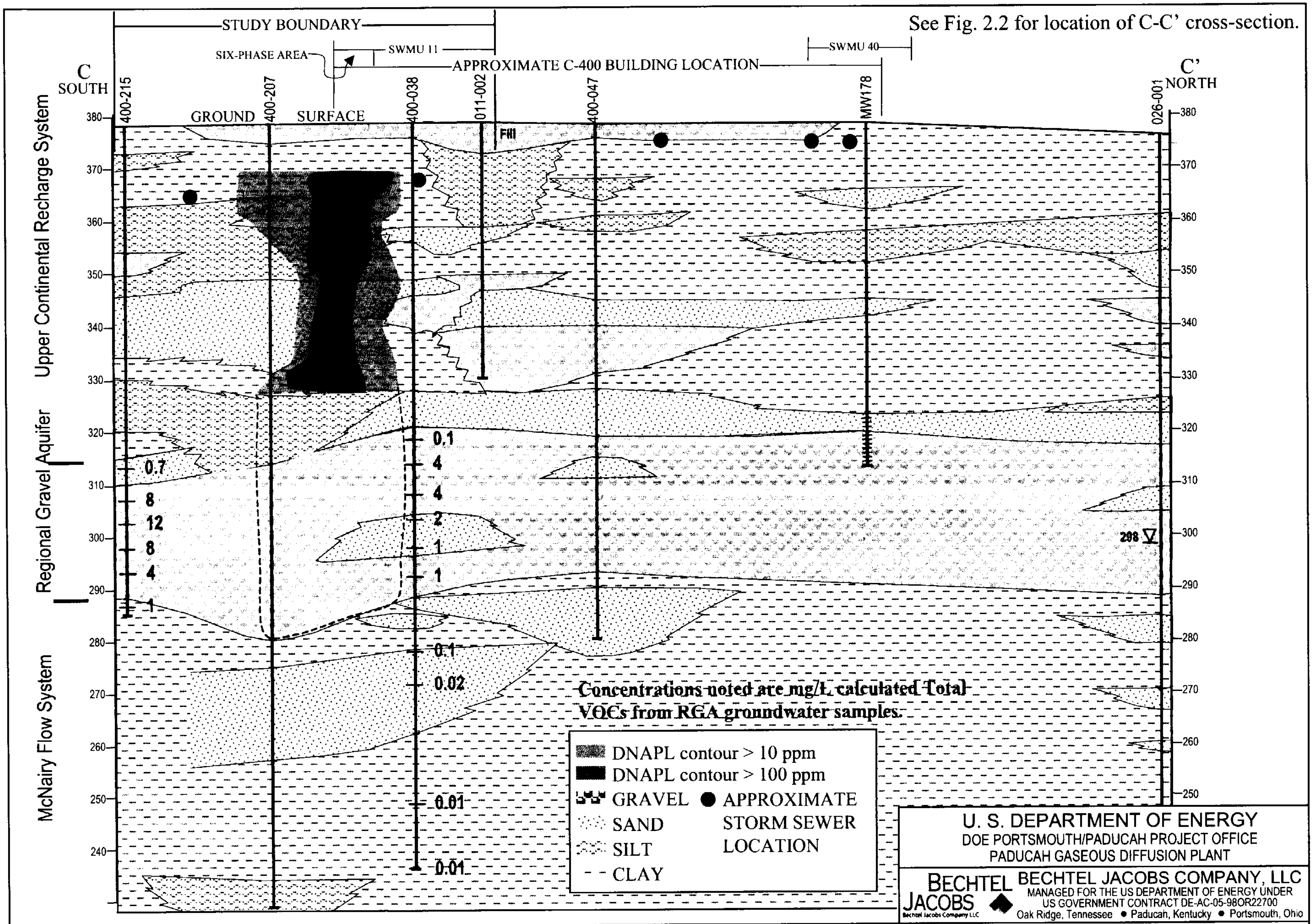

Fig. 3.7. North-south C-C′ cross-section showing VOC contamination near C-400.

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4. TECHNICAL APPROACH FOR THE SUPPORT INVESTIGATION

Profiling with MIP has proven effective at characterizing VOC occurrence in shallow soils (to depths of 50-to-60 ft) in the vicinity of the C-400 Building. The RDSI Subcontractor will use MIP to further define the distribution of VOC contamination in soil throughout the thickness of the UCRS and into the RGA. In the event that the MIP, alone, proves unable to advance through the thickness of the RGA, the RDSI Subcontractor will use a conventional drilling system, such as rotary sonic, dual-wall reverse circulation (DWRC), or hollow-stem augers (HSAs), to continue the MIP to the base of the RGA. The MIP would "sample" the RGA at 5-ft intervals throughout the depth of the aquifer, preferably by pushing the MIP into the formation through the base of the drill rods or augers or, upon the approval of the DOE Prime Contractor,[2] by exposing the MIP to formation water inside the drill rods or augers.

4.1 SUPPORT INVESTIGATION OBJECTIVES

This Sampling Plan presents the basic strategies that apply to characterization of the south C-400 DNAPL zone as part of the RDSI. Both planned and contingency borings are identified. Planned borings will be placed near the suspected perimeter of the DNAPL zone to define extent and will be placed adjacent to previous boreholes with documented VOC contamination levels, to check the general response of the MIP and assess trends in VOC contaminant levels since the WAG 6 RI. The characterization strategy is based on the use of MIP to provide qualitative, real-time data. Because the MIP is a qualitative tool, previous subcontractor experience and experience gained on-site will be the primary guidance for determining the MIP response to DNAPL. The problem statement for this investigation reads:

Existing characterization data for the south C-400 area, notably data from the WAG 6 RI, delineate a zone of soil and groundwater in the UCRS and RGA that is contaminated by high concentrations of TCE that are indicative of the presence of DNAPL. Other VOCs are known to be present. Optimal placement of a remediation system requires further refinement of the known magnitude and extent of the zone of highest contaminated soils and groundwater.

The following is the principal study question to be answered for this investigation.

What is the relative magnitude and extent of the high-concentration zone of total VOCs in the UCRS (concentrations in soil equal to or greater than 10 ppm) and RGA (concentrations in groundwater equal to or greater than 100 ppm) of the south C-400 area?

The decision rules that flow from the principal study question are these.

The standard and preferred deployment of MIP is by DPT. If the DPT system provided for the RDSI proves incapable of pushing the MIP system to the planned depth of a

---

[2] Where the RGA must be characterized using a conventional drilling system, the RDSI Subcontractor will be required to "sample" the RGA by pushing the MIP probe into the formation "ahead" of the drill rods or augers unless the method proves unworkable in the RGA in the C-400 area. The RDSI Subcontractor must obtain the approval of the DOE Prime Contractor before characterizing the RGA by the VOC levels in formation water within the drill rods or augers.

characterization boring, then the RDSI will use a conventional drilling system to advance the MIP to the planned depth.

The RDSI Subcontractor is required to provide geophysical logs (natural gamma log and/or soil conductivity log) of the total depth of each characterization borehole, to be used by the Remedial Design Subcontractor to map subsurface geologic units in the area of the IRA. For portions of the characterization boring that are completed using DPT, the RDSI Subcontractor will provide a soil conductivity log of the boring. If a characterization boring is completed using conventional drilling techniques, then the RDSI Subcontractor also will provide a natural gamma log of the total length of the boring.

Available characterization data for the south C-400 area, most notably the WAG 6 RI, outline a zone of soil and groundwater highly contaminated with TCE. Other VOCs are known to be present. If planned characterization borings for the RDSI do not delineate the extent of the DNAPL zone in the UCRS and RGA in the south C-400 area (other than beneath the C-400 Building), then continue the investigation with allotted contingency borings until the DNAPL zones are delineated.

If the planned and allotted contingency borings do not define the extent of the DNAPL zone, the conceptual model of the DNAPL zone is invalid. In that event, the RDSI Subcontractor will propose a plan of additional characterization of the DNAPL zone to the Contractor and await the concurrence of the Contractor before proceeding (regulatory approval may be necessary prior to implementing the proposed additions).

Note that the RDSI Subcontractor is not required to report the results of the south C-400 characterization in any investigation report. A decision rule that applies to the Remedial Design Subcontractor following the completion of the RDSI is this:

If the RDSI characterization data do not agree with the conceptual model of VOC DNAPL in the south C-400 area, as documented in Section 3.3 of this Characterization Plan, then the Remedial Design Subcontractor must develop a revised conceptual model that incorporates the RDSI data to be used in the design and implementation of the IRA. The Remedial Design Subcontractor will include in the Remedial Action Work Plan the analysis of the RDSI information to identify the area to be treated for the IRA.

The existing data set that was used to develop the conceptual model of the extent of DNAPL has several insufficiencies. Although the WAG 6 RI resulted in an extensive collection of soil and groundwater analyses, the documented contamination levels in 1997 may not be representative of current conditions. These data are best used as a guide for planning additional characterization. The Six-Phase Heating Treatability Study provided soil and groundwater analyses in 2003. However, the samples are limited to a small area of the southeast C-400 block. It remains possible that the heating and subsequent cooling associated with the treatability study resulted in migration of contamination that has not been subsequently characterized. PGDP maintains a continuing groundwater monitoring program that provides a basis for assessing trends in contaminant levels. However, the monitoring program does not include wells that are optimally located upgradient of the C-400 DNAPL zone and has no wells close to the southwest corner of C-400.

Additional characterization of the C-400 DNAPL zone faces several challenges. The C-400 infrastructure and daily and routine operations severely limit access. Moreover, known areas of soil contamination (radioactivity) and security concerns add restrictions to the field operation. Use of MIP in a

DNAPL zone risks saturation of the gas chromatograph detectors, potentially necessitating a lengthy "down time" to purge the detectors of contamination.

4.2 SITE UTILITY SURVEY

The vicinity of the south end of the C-400 Building overlies many buried utilities that provide essential services for the operation of PGDP. An excavation/penetration permit program exists to minimize the potential for damaging buried utilities. At a minimum, an engineer will be required to consult plant utility drawings and perform subsurface surveys of each borehole location to mark buried utilities prior to the initiation of a characterization borehole. Typical subsurface survey instruments used at PGDP for the south C-400 block include a cable locator, EM-38, and ground penetrating radar.

4.3 HEALTH AND SAFETY

The Remedial Design Subcontractor will complete an Environmental, Safety, and Health Plan (ES&HP) for this RDSI prior to field implementation. The ES&HP establishes the specific applicable standards and practices to be used during execution of the Characterization Plan to protect the safety and health of workers, the public, and the environment. The ES&HP incorporates directly, or by reference, federal and state standards, pertinent consensus standards, and applicable contract requirements. The ES&HP will be implemented in accordance with 29 *CFR* 1926.65, Hazardous Waste Operations and Emergency Response. Additional specific health and safety requirements will be incorporated into the ES&HP by completion of activity hazard analyses for the various field activities that comprise the RDSI.

The ES&HP will evolve as "lessons learned" are incorporated to improve continuously the work processes, while maintaining focus on the functions and guiding principles of the Integrated Safety Management System and the zero-accident performance philosophy. The ES&HP will be completed and approved by the DOE Prime Contractor before commencing fieldwork.

VOCs are a known hazard to be addressed for the RDSI. Technetium-99 (^{99}Tc) is a significant groundwater co-contaminant in the RGA of the C-400 area. (^{99}Tc activity is not a concern in the UCRS of the south C-400 area.) In the most recent update of groundwater plume maps for PGDP (DOE 2005), ^{99}Tc contamination in the RGA in the vicinity of the south end of the C-400 Building ranged in the 100-to-900 pCi/L level. (For ^{99}Tc, 900 pCi/L is generally accepted as the maximum contaminant level.) RGA groundwater samples of the WAG 6 RI documented beta radiation activity (the primary ionizing radiation associated with ^{99}Tc) as high as 828 pCi/L in the south C-400 Building area; with beta activities significantly higher in the lower RGA. Thus, ^{99}Tc contamination will be a potential concern of any RGA purge water of the RDSI.

Electrical resistance heating is intended to produce a large volume of steam derived from heating of the RGA. The Six-Phase Heating Treatability Study showed subsurface temperatures can be expected to remain at approximately 100°C during the operation of electrical resistance heating. Because the boiling point of ^{99}Tc metal is 4265°C (CRC 1991) and the boiling point of pertechnetate salts of some common metals (the usual form of ^{99}Tc in the environment) ranges from 650°C to 700°C (DOE 1982), ^{99}Tc will not be a significant component of the off-gas waste stream.

4.4 DRILLING/SAMPLING METHODS

Existing characterization data are sufficient to define the nature of contamination and general magnitude of VOC levels to be expected in the DNAPL zone. Soil samples of the WAG 6 RI determine the approximate extent of the VOC DNAPL zone in the UCRS on the south end of the C-400 Building. Groundwater samples from the RGA provide less detail, but indicate that an RGA DNAPL zone exists under the same general area. The extent of the RGA DNAPL zone is poorly known.

This RDSI is intended to refine the definition of the extent and magnitude of VOC contamination in the UCRS and RGA DNAPL zones. The goals of the RDSI do not require analytical data as used for risk analysis. Instead, the Remediation Design Subcontractor will use MIP to provide a real-time, nearly-continuous profile of VOC contamination versus depth in the field. The technology uses a probe incorporating a heating element and permeable membrane in the subsurface, tied back to various types of analytical equipment at the surface. A MIP probe typically is pushed using DPT. As the probe is pushed downward through the soil column, the soils adjacent to the heating element are heated to a temperature sufficient to vaporize any VOCs present in the soils. The vapors enter the probe through a porous membrane and are transported to the surface using an inert carrier gas and tubing. Contamination of the gas transfer tubing is a potential problem with MIP. The MIP operator will be required to employ practices to address this sampling problem.

The vapors then are processed through an array of sensors and analytical equipment that can range from a simple photoionization detector (PID) to a gas chromatograph/mass spectrometer (GC/MS) to a direct sampling ion-trap mass spectrometer. Depending on surface instrumentation, the method provides a nearly continuous qualitative to semi-quantitative profile of VOC concentrations versus depth. To reduce the possibility of overloading analytical systems, a PID may be used to screen the vapor stream for high concentrations of VOCs prior to introduction to the more sensitive analytical system used to quantify the VOCs.

MIP probes have routinely sampled through the thickness of the UCRS in the vicinity of C-400. This Characterization Plan requires the driller to advance the MIP system via DPT through the UCRS. Where the Sampling Plan requires characterization of the RGA, the driller must advance the MIP probe through the UCRS and into the RGA to the shallower of "refusal" depth or the base of the RGA. DPT, in general, typically has met refusal at the top of the RGA.

The driller must be prepared to advance the MIP probe using a conventional drilling system to sample through the RGA.[3] In such an event, the MIP will be required to characterize VOC levels across the thickness of the RGA at 5-ft intervals. The drillers must place the MIP probe at the characterization intervals by either of two "sampling methods":

1. by drilling to one ft above the "sample" depth and pushing the MIP probe, through the hollow drill string, to one ft below the depth reached by the drill bit; or

2. by drilling to the "sampling" depth and opening the hollow drill string to formation water, purging one water-filled volume of the drill string to minimize cross-contamination concerns, and placing the MIP probe inside the hollow drill string near the drill bit to "sample" formation water.

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[3] Working area is limited in the south C-400 area. The RDSI Subcontract driller is encouraged to provide a drill rig with DPT capability to avoid the need for a separate DPT rig when "sampling" in the RGA.

Note: the first "sampling method" is the preferred approach and is to be used unless proven to be ineffective. The second "sampling method" can only be used with the approval of the DOE Prime Contractor.

"Flowing sands" is a frequent drilling-related phenomenon in the RGA. When a "flowing sand" horizon is encountered, a slurry of sand floods up into the hollow drill string. Once present inside the hollow drill string, these sands would make it difficult to place the MIP probe, prevent the standard retrieval of the inserted MIP probe, or frustrate attempts to re-seat a center drill bit. The RDSI Subcontractor must be prepared to address "flowing sand" problems, while minimizing the impact of recovery operations on "sample" quality.

As a means of logging high-permeability intervals in the soils, the MIP subcontractor will be required to provide a soil conductivity profile of each boring through the UCRS and to the total depth of the DPT borehole. For boreholes completed in the RGA by other drilling methods, the MIP subcontractor will be required to provide a natural gamma log of the entire depth of each soil boring.

The MIP system is based on DPT methods, but could be deployed within a rotary sonic, DWRC, or HSA boring. Rotary sonic and DWRC methods are preferred because they do not require the placement of isolation casing in DNAPL zones, such as required for drilling with HSAs; therefore, HSAs can only be used with the approval of the DOE Prime Contractor. The rotary sonic drilling method is preferred over the DWRC drilling method because the DWRC "vents" an air stream at land surface that has been in contact with formation water. Volatilized TCE and other VOCs in the breathing zone will be an increased concern for project and other site personnel if DWRC is used. The following paragraphs briefly describe each of the three drilling methods that can be used with the MIP.

Rotary Sonic

Rotary sonic drilling uses two concentric strings of drill pipe with a drill bit designed to create minimal annular space between the drill pipe and borehole wall. This configuration virtually eliminates vertical cross-contamination.

Rotary sonic drilling uses a combination of rotational movement and sonic resonance, which vibrates the drill string down through the sediments. The vibratory motion displaces the sediments laterally. The sediments near the outside of the drill string are pushed to the side of the borehole, while the sediments nearer the center of the drill string are captured as a core in a sleeve in the inner string of drill pipe. This drilling method results in a continuous core of sediments from the surface to the total depth of the hole as a natural by-product of the drilling process. If water is added to the formation during drilling, purging prior to use of the MIP will be required.[4] Once the purge pump is withdrawn from the drill pipe, a MIP probe is placed inside the drill pipe in accordance with the intended "sampling" method and the interval is characterized. After the measurements are completed, the MIP assembly is withdrawn, and the hole is deepened to the next planned depth.

Waste generation consists of the soil core and water. Drill cutting volumes are near the theoretical hole size since only the soils in the core sleeve are recovered at the surface. Potable water is used to reduce friction and to help displace drill cuttings and may return to the surface as wastewater. The volume of purge water produced is dependent on how much water is used during drilling.

[4] The preferred method for drilling with rotary sonic, to minimize bias to RGA VOC levels in the vicinity of the drill rods, is to drill the RGA interval without the addition of water or other drilling fluid.

Rotary sonic drilling has been used during the WAG 6 RI, the Site 3A Seismic Investigation, and the Site Investigations for the Southwest Plume and the C-746-S&T Landfill complex.

Dual-Wall Reverse Circulation

DWRC is an air rotary drilling method using two concentric strings of drill pipe. In traditional air rotary drilling, the air travels through the center of the drill pipe, exits the bit, and returns to the surface by way of the annulus between the borehole wall and the drill pipe. The DWRC method is different from air rotary drilling in that the air used to lift the drill cuttings to the surface goes down the annulus between the two strings of drill pipe, exits at or near the drill bit, and returns to the surface through the center of the drill pipe. The drill bit is only slightly larger in diameter than the outer diameter of the outer drill string, resulting in almost no annular space between the drill pipe and the borehole wall. To prevent oil contamination of the air stream, a filter normally is placed at the outlet side of the air compressor and is required if this drilling method is selected for the investigation.

When the "sample" interval is reached, rotary drilling stops, but air circulation is maintained for a brief period to clear the hole of cuttings. After air circulation stops, water from the sample interval enters the drill pipe through the bit. Because some warm air and water from the drill rig will enter the interval being sampled, purging prior to use of the MIP will be required. Once the purge pump is withdrawn from the drill pipe, a MIP probe is placed inside the drill pipe in accordance with the intended "sampling" method and the interval is characterized. After the measurements are completed, the MIP assembly is withdrawn and the hole is deepened to the next planned depth.

Waste generation consists of drill cuttings and water. Drill cutting volumes are near theoretical hole size, since the air circulation does not erode the borehole wall. The volume of water produced is dependent on the productive capacity of the sediments. Aquifers capable of producing large volumes of water can result in significant wastewater volumes.

In normal operation, the DWRC system circulates a high rate of air that will dilute entrained VOC concentrations. When drilling in areas with soil containing high VOC concentrations, VOC levels in the off-gas may pose a significant risk to the drill crew and site workers.

DWRC drilling has been used for groundwater characterization at PGDP in the Phase IV Investigation; the Northeast Plume Interim Remedial Action; the WAG 6, WAG 27, WAG 28, and WAG 3 RIs; the "Data Gaps" investigation, and the Site Investigations for the Southwest Plume and the C-746-S&T Landfill complex.

Hollow Stem Auger

For use with MIP, the augers are fitted with a center bit, held in place by center rods, to prevent the entry of cuttings during drilling. The driller advances the augers to the planned depth and then withdraws the center rods and center bit. A MIP probe is placed inside the augers in accordance with the intended "sampling" method, and the interval is characterized. After the measurements are completed, the MIP assembly is withdrawn; the center bit is replaced in the augers; and the hole is deepened to the next planned depth.

An advantage of HSA drilling is the augers do not require the addition of drilling fluids or result in inadvertent loss of air to the formation during drilling; thus, HSA drilling offers less potential to bias VOC levels in the "sample" intervals.

There are two primary disadvantages of HSA drilling. Waste soil volumes exceed the volume of the borehole because the drilling action increases the porosity of the soil cuttings. (Waste soil volumes with DWRC and rotary sonic drilling typically are close to the borehole volume.) If HSA is used, a temporary isolation casing will be required for the soil boring intervals in the UCRS where the MIP has documented the presence of DNAPL in the UCRS. (The minimal annular space of the DWRC and rotary sonic drilling methods significantly lessens the potential for DNAPL migration and, thus, does not require the placement of temporary isolation casing.) Where isolation casing is used, a 24-hour "hold" period must be incorporated into the drilling to allow the isolation casing seal to cure before drilling proceeds. Isolation casings will have to be removed as part of the plugging and abandonment of the borehole.

HSA drilling has been used extensively for soil sampling and installation of monitoring wells at PGDP, including the Phase II Site Investigation, the Northwest Plume Investigation (in conjunction with DPT), and the WAG 27, WAG 28, and WAG 3 RIs.

4.5 BORING ABANDONMENT

After the boring is completed, the borehole will be plugged and abandoned as soon as possible. Boring abandonment will be consistent with Commonwealth of Kentucky requirements and approved site procedures. High solids bentonite grout (at least 30% by weight) typically is used. However, the grout for these boreholes must be adequate to seal the borehole during the application of electrical resistance heating. Borehole plugs will be susceptible to desiccation and blowouts due to the high underground temperatures generated by electrical resistance heating and the associated steam pressures. Cement grout might be more appropriate. The RDSI Subcontractor will identify the proposed grout for use in sealing the boreholes, and the DOE Prime Contractor must approve the borehole grout prior to the commencement of drilling.

The driller will be required to abandon all borings, created both by DPT and by conventional drilling method, by placing the grout in the borehole with a tremie pipe, proceeding from the base of the open borehole to be abandoned to near ground surface. For boreholes completed in the RGA with a drilling system, the following bullets are a synopsis of the process.

- Pull the drill pipe or augers up to the top of the RGA to allow the formation to collapse and fill the hole. If the RDSI Subcontractor can obtain the approval of the Kentucky Department for Environmental Protection, use clean sand to fill any remaining hole in the RGA.[5]

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[5] Experience at the PGDP with grouting boreholes in the RGA and the annulus of wells completed in the RGA indicates that a significant volume of grout may be lost to the RGA matrix. This grout likely penetrates the most permeable zones preferentially and will impact those horizons (e.g., sealing the permeable zones and impacting the groundwater chemistry) for an extended distance around the borehole. Any increase of fine-grained material in the RGA is undesirable in the area of Electrical Resistance Heating. As evidenced by the PGDP Six-Phase Heating Treatability Study, fine-grained material can be mobilized into the vapor recovery wells, which would plug the waste management and treatment systems.

Where soil borings are not grouted through the RGA interval, the RGA matrix typically collapses into the borehole as the drill string is removed. This process increases the permeability of the RGA matrix in the vicinity of the borehole over a limited distance. The addition of sand to fill any remaining open borehole in the RGA would create a relatively low permeability zone in the borehole (beneath the PGDP, the RGA often is a sandy gravel with very high permeability). The sand would stabilize the RGA matrix in the vicinity of the upper RGA borehole and limit the distance of penetration of grout from the overlying UCRS borehole. Moreover, the sand would not be mobilized for any appreciable distance by the flow of groundwater and steam during Electrical Resistance Heating.

- As the drill pipe or augers are withdrawn from the UCRS borehole, add grout to the hole by tremie pipe, to within 18 in. of the ground surface.

- Once the rig is moved off the hole, rope off the area around the boring for safety.

- After 24 hours, check the grout level and add grout, if necessary. If bentonite grout is used to plug the borehole, the grout level may be topped off with bentonite pellets that are placed by tremie pipe and hydrated in one ft lifts.

- When the grout level has stabilized, fill the remaining 18 in. of the hole. Where the land surface is not paved, fill the remaining hole with soil to ground level. Where the land surface is paved, fill the hole with material similar to the pavement.

4.6 DECONTAMINATION PROCEDURES

Decontamination of all drilling-related equipment, MIP probe, and other down-hole equipment will be completed in accordance with DOE Prime Contractor-approved procedures and EPA procedures and protocols. The purpose of the RDSI is to characterize the extent of soils with significant VOC contamination. As such, the occurrence of low levels of cross contamination on any drill string and drill rig used for the investigation will not appreciably impact the results of this investigation; thus, typical criteria to determine the need for decontamination may be relaxed. As such, the down-hole MIP probe will require decontamination after completing each borehole, but the decontamination of a DPT rig or drill rig and drill rods may be required only as needed to prevent the bias of characterization data and contamination of field personnel and the environment.

The PGDP has two active decontamination facilities. C-416 is the closest decontamination facility to the C-400 area, located immediately south of the C-337 Process Building. It consists of a fenced concrete pad that slopes to an internal sump. The facility is not covered, so that any rainfall during a project becomes project wastewater. C-752 is a covered decontamination facility consisting of a concrete pad with sumps, located south of the main industrial area of the PGDP. The DOE Prime Contractor will determine the decontamination facility to be used for this investigation based upon availability.

Personal protective equipment (PPE), clothing, and decontamination procedures for the implementation of the RDSI will be addressed in the ES&HP for the RDSI.

5. SAMPLING AND ANALYSIS PLAN

This RDSI uses MIP to qualitatively characterize VOC levels in soils of the UCRS and RGA at the south end of the C-400 Building. There will be no sample analyses of soils or groundwater as part of this fieldwork other than characterization of project-generated waste materials. Specific analytical requirements, methods, and procedures for waste characterization will be described in detail in the Quality Assurance Project Plan (QAPP) (Appendix A) for this RDSI.

The general sampling strategy for this SI focuses on MIP characterization using DPT through the UCRS. Where characterization of the RGA is required, the DPT will be used to advance the MIP to the base of the formation or to the depth of refusal (anticipated near the top of the RGA). Upon DPT refusal, where encountered, a drilling system will be used to continue the soil boring to the base of the RGA, pausing at 5-ft depth intervals to characterize the VOC levels with the MIP probe. Three drilling methods used previously at PGDP that could be used to advance the MIP probe are rotary sonic, DWRC, and HSA drilling. The potential drilling methods and requirements for drilling and abandonment are described in Sect. 4.4 of this Characterization Plan.

5.1 SOIL AND GROUNDWATER SAMPLING

All characterization of VOC levels in the DNAPL zone will be performed with the MIP. This data will be qualitative.

5.2 WASTE MANAGEMENT SAMPLING

Wastes generated during this project will be characterized and disposed of as soon as practicable. Waste sampling will be performed from containerized waste, utilizing existing data to the maximum extent possible. All samples will be sent to a fixed-base laboratory as arranged by the Sample Management Office for analysis. Details of the sampling and analytical requirements for waste characterization will be described in a Waste Management and Disposition Plan (WM/DP) for the RDSI, to be written by the Remedial Design Subcontractor following the selection of the drilling method to be utilized. DOE will provide a copy of the WM/DP to the Kentucky Division of Waste Management for informational purposes.

5.3 ANALYTICAL REQUIREMENTS

The primary data derived from the field project will be qualitative total VOC levels, as provided by the MIP. The existing characterization data for soil and groundwater samples from the south end of C-400 indicates that TCE will be the dominant VOC present.

Secondary data from the field project will include soil conductivity and natural gamma logs. These borehole logs are intended to provide the Remedial Design Subcontractor with a means to assess the continuity of geologic units within the remediation area.

5.4 SAMPLING SEQUENCE

USEC operations within the study area will dictate access to the C-400 block. In general, the Remedial Design Subcontractor will sequence the series of characterization borings to complete locations with UCRS-only characterization before sampling locations that include RGA characterization, and to proceed from areas that are presumed to contain lesser levels of VOC contamination to areas that are presumed to contain greater levels of VOC contamination. The intent of characterizing the UCRS-only locations before the RGA sample locations is to begin to identify areas of the south C-400 block where drilling presents significant risk of mobilizing DNAPL downward into the RGA (without risking significant DNAPL mobilization). This Characterization Plan requires the installation of temporary isolation casing in these areas if HSA drilling is used, to separate UCRS DNAPL zones from the completion of the borehole into the RGA.

By proceeding with the characterization borings from outside the main contamination area to inside the main contamination area, the RDSI will achieve the successive four benefits:

- minimize the chance of significant cross contamination of soils and groundwater;
- acclimatize the drill crew to work on a DOE facility in less contaminated environments;
- build up site experience of the drill crew in the proximity of high VOC levels; and
- develop site experience with the MIP response to high VOC levels prior to encountering DNAPL.

The sampling and drilling required for characterization of VOC levels in the south C-400 block presents significant potential risk to the following:

- health and safety of the drill crew,
- health and safety of PGDP operations workers in the vicinity of the investigation,
- the environment, and
- operation of the plant.

The drill crew will immediately cease operation and alert project management in the event that unexpected conditions are encountered (e.g., DNAPL occurrence outside of the suspected area of the UCRS soils that were directly impacted by TCE spills or discovery of unanticipated subsurface obstructions).

5.5 SAMPLE PLAN

The Sample Plan for this RDSI consists of MIP borings in selected cells of a grid of the south C-400 block. Grid axes are oriented parallel to the main axes of the plant coordinate system; and grid dimensions in both the east-west and north-south directions are either 25 ft or 50 ft so that the grid provides greater resolution near the perimeter of the approximate 0.5-acre area initially targeted for the IRA (Fig. 5.1). (Note: Fig. 5.1 shows the grid in relation to historical sample locations of UCRS soil in the south C-400 area. The mapped sample points are not planned sample locations.)

This Sample Plan attempts to optimize the RDSI by filling data gaps left by the historical analyses where documentation of TCE levels will be most critical to the design of the electrode network for electrical resistance heating. The following four criteria guided selection of grid cells for additional UCRS characterization:

1. lack of UCRS soil analysis for the upper, middle, or lower UCRS,
2. proximity to suspected DNAPL source zones,
3. proximity to the perimeter of the approximate 0.5-acre area that is targeted for treatment in the IRA, and
4. location otherwise chosen for RGA boring.

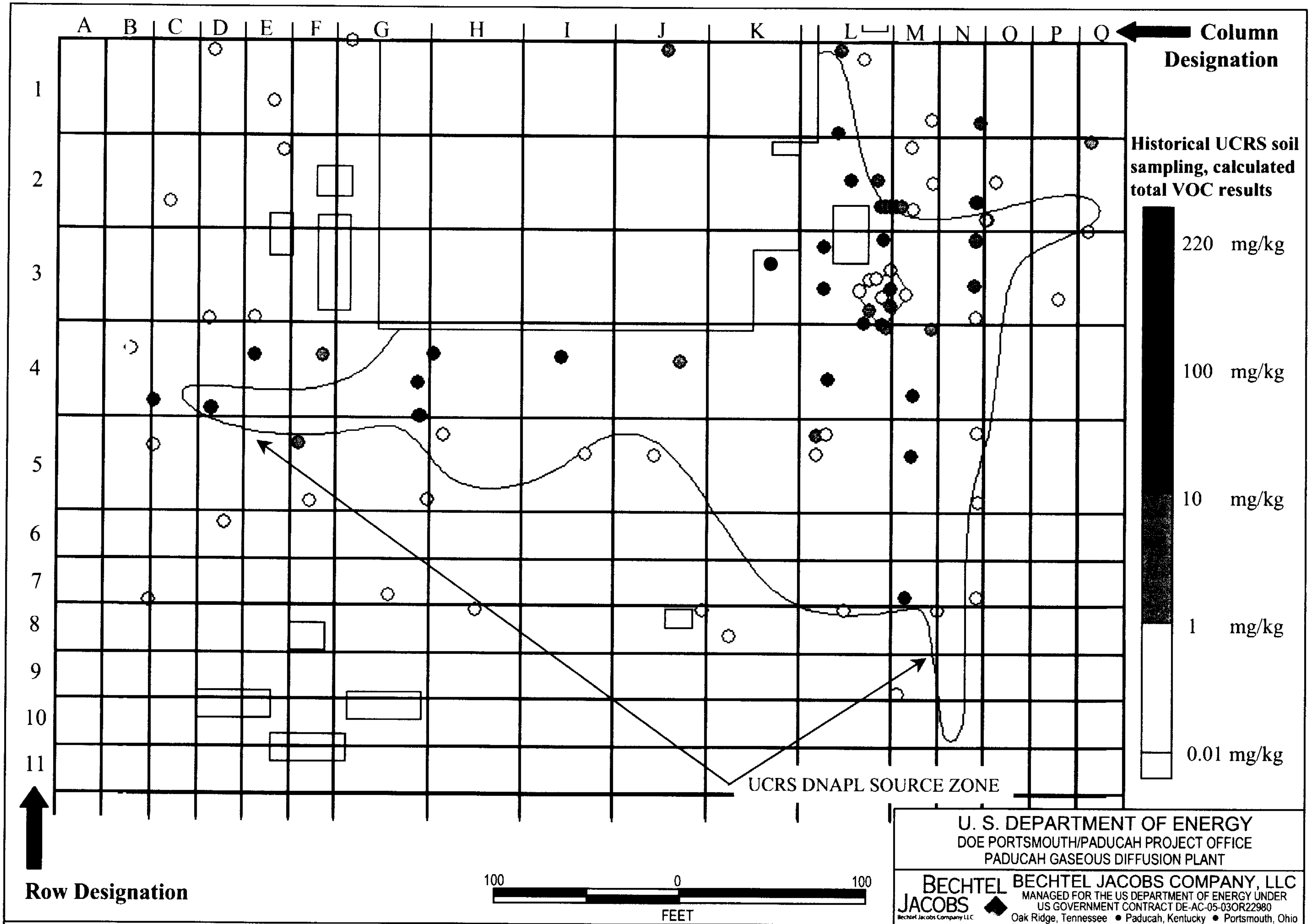

Fig. 5.1. South C-400 sample grid.

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For the UCRS, 46 grid cells (Fig. 5.2) require additional characterization. The RDSI consists of one MIP boring per selected grid cell. Each MIP boring will be required to characterize the total depth of the UCRS (approximately 55 ft in the south C-400 area).

Several grid cells with 1st and 2nd priority UCRS characterization boreholes identified on Fig. 5.2 have historical sample locations of UCRS soils, as identified on Fig. 5.1. In most cases, the data from historical boreholes in these locations represents only the upper 10-to-15 ft of soils. Additional data in these locations are important to define the 3-dimensional extent of the DNAPL source zone(s). A select few historical borings are being duplicated with the MIP to assess changes in VOC levels over time.

Assuming that not all of the identified boring locations will be able to be sampled,[6] Fig. 5.2 assigns priority to the UCRS boreholes. These priority designations are intended to reflect the relative importance of the sample location to the characterization of the nature and extent of the VOC contamination (and should not be confused with the intended order of completion of the borings). If required, the RDSI Subcontractor should make exceptional effort to sample the 1st priority boreholes. The RDSI Subcontractor may elect to forego sampling at locations for 3rd priority boreholes in some cases. First priority boreholes often are located near the suspected DNAPL source zones; in general, these should be sampled last.

The 18 locations with UCRS characterization only (to be sampled first) are located in the following grid cells (refer to Fig. 5.2):

A4	C5	I4	L7	M6	O1
C3	E4	K3	M3	M7	O2
C4	F5	L1	M4	N7	O3

Few groundwater analyses are available for the RGA in the south C-400 block. This Sample Plan directs characterization efforts in four areas, based on the location of suspected DNAPL zones in the lower UCRS and the RGA and the location of elevated levels of contamination in the dissolved-phase plume. The four areas for focused RGA characterization are as follows:

- east and upgradient of the DNAPL zone associated with TCE transfer pump (also includes one boring downgradient of the source zone and one boring within the suspected source zone);
- east and upgradient of the DNAPL zone associated with C-400 TCE Leak Site;
- north of the DNAPL zone associated with C-400 TCE Leak Site; and
- upgradient, east, and west of the DNAPL zone in the southwest C-400 block.[7]

The known trend of the Northwest Plume indicates that the upgradient direction in the south C-400 area, in general, is to the south and southeast.

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[6] Factors that might prevent a boring location from being sampled include interference with USEC operations, presence of surface obstructions and underground utilities, proximity to overhead power lines, presence of radiological contamination, and national security restrictions.

[7] In the area of the DNAPL zone in the southwest C400 block, existing sample analyses (from the WAG 6 RI) indicate that higher TCE-in-soil-levels are limited to within 50 ft of the south side of the C-400 Building. It is anticipated that the planned MIP characterization of grids G5, H5, and I5, reviewed with the WAG 6 RI data, will be sufficient to document adequately the southern extent of the contamination zone to be treated.

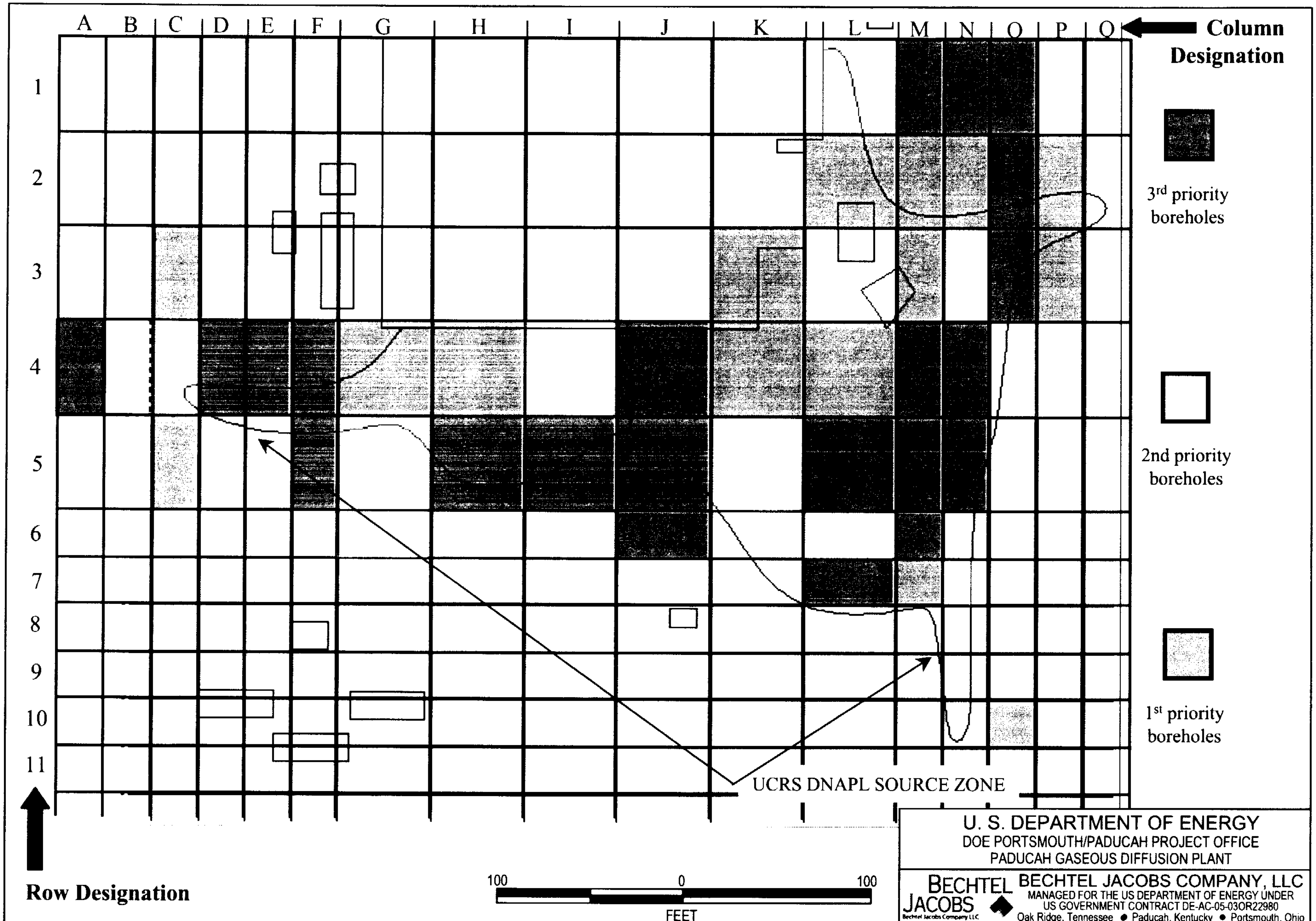


Fig. 5.2. Sample plan for the UCRS

Dissolved TCE levels are not anticipated to discriminate between DNAPL zones and areas that are located immediately downgradient of the DNAPL zone. Except for the C-400 TCE Leak Site where the DNAPL zone is anticipated to be limited to the UCRS and the uppermost RGA, only one RGA boring is proposed to be located downgradient of a suspected DNAPL zone. The Sample Plan orders the RGA borings to proceed "outside-in" at each of the four areas. Figure 5.3 illustrates the Sample Plan for the RGA borings. The following sequences define the intended order for sampling the four areas of RGA characterization (see Fig. 5.3 for the cell IDs).

East and upgradient of the DNAPL zone associated with TCE transfer pump:

O10→J6→J5→N5→L6→K5→J4→M5→L5→K4→L2 (downgradient)→L4 (DNAPL source zone)

East and upgradient of the DNAPL zone associated with C-400 TCE Leak Site:

P4 (east)→P3→P2→N4 (upgradient)

North of the DNAPL zone associated with C-400 TCE Leak Site

M1→N1→M2→N2

Upgradient, east, and west of the DNAPL zone in the southwest C-400 block

G6 (upgradient)→G5→I5 (east)→H5→B4 (west)→D4→F4→H4→G4 (DNAPL source zone)

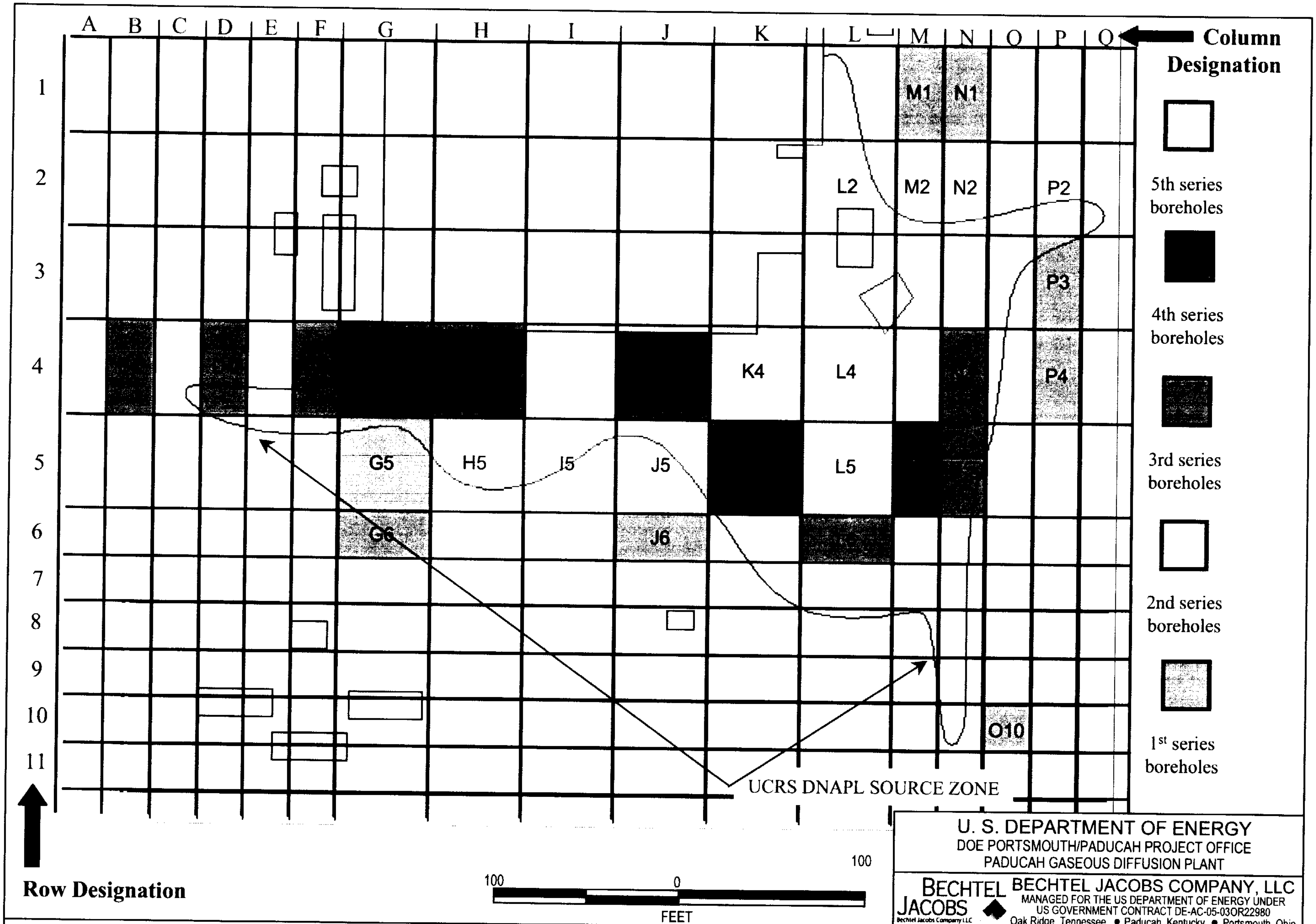
The Sample Plan for the RGA consists of 29 characterization borings. Each cell selected for RGA "sampling" will be characterized by one boring per cell with the boring to extend to the base of the RGA (approximately 92 ft deep at the south C-400 area).

This sample plan anticipates the need for contingency borings to define the extent of the UCRS and RGA DNAPL zones. Four borings, to be located based on RDSI results, upon the consensus of the DOE Prime Contractor and the RDSI Subcontractor, are available for contingency. Should these characterization borings not define adequately the upgradient and cross gradient limits of the UCRS and RGA DNAPL zone(s), the RDSI Subcontractor will propose a plan of additional characterization of the DNAPL zone(s) to the DOE Prime Contractor and await the concurrence of the DOE Prime Contractor before proceeding. As part of the DOE Prime Contractor review of this proposed additional characterization, the DOE Prime Contractor will offer opportunity to the Kentucky Division of Waste Management to comment on any new characterization plan.

5.6 COST-TO-BENEFIT ANALYSIS OF ADDITIONAL SOIL CHARACTERIZATION FOR C-400 REMEDIAL DESIGN SUPPORT INVESTIGATION

Once the planned characterization has been completed for the RDSI, it is anticipated that data gaps will be apparent. The RDSI Characterization Plan allots four additional borings to address remaining uncertainties and specifies a process for review and approval of additional characterization borings, should they be required. The four additional borings permit limited additional characterization. If more borings are required, the conceptual model of the DNAPL source zones likely is inadequate and the DOE Prime Contractor and the RD Subcontractor should perform a review of the recently acquired data before proceeding.

The following outlines a preliminary cost-to-benefit analysis of additional characterization borings. Specific results of the RDSI will dictate the outcome of the planned investigation and cannot be anticipated. This analysis is based upon assumptions that should be evaluated when the benefit of additional characterization is evaluated.



U. S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

Fig. 5.3. Sample plan for the RGA

Assumptions

For this analysis, it has been assumed that the RDSI proceeded according to the Characterization Plan, with good results obtained with the MIP. Furthermore, to simplify the analysis, it is assumed that all characterization borings were drilled in the center of the designated grid cells.

The following approach assesses the value of "in-fill" drilling and characterization to potentially reduce the area of the treatment zone. Grid cells within the treatment zone typically measure 50 × 50 ft. Thus, it will be assumed that the characterization borings completed as part of the planned investigation are located on 50-ft "centers." Assuming that the uncertainty of TCE soil concentrations is uniformly distributed, additional characterization would likely proceed in a regular pattern by limited "in-fill" drilling. A uniform approach to "in-fill" drilling likely would be based upon four additional borings to characterize a single 50 × 50 ft grid cell. For a larger area consisting of multiple grid cells, five additional borings likely would be used to characterize the first grid cell with four additional borings required to characterize each additional grid cell. For the purpose of this assessment, it is assumed that each 50 × 50 ft grid cell requires four additional borings for characterization.

Very little literature is available to document the size of an electrical resistance heating treatment cell. The electrodes of the 6-Phase Heating treatment cell of the C-400 Treatability Study were placed on 15 ft "centers." According to the C-400 Treatability Study Work Plan (DOE 2001b), the maximum spacing between electrodes is 22.5 ft. The length of the electrodes, soil characteristics, and applied power determine the maximum electrode spacing. (For comparison, a 17-ft spacing was used for a 3-Phase Heating remedial action at Air Force Plant 4 in Fort Worth, TX.) Because combinations of a 17-ft spacing neatly approximate filling a 50 × 50 ft grid, this analysis assumes the electrical resistance heating electrode network consists of a 17-ft electrode spacing in a 3-Phase Heating pattern.

A 50 × 50 ft grid has a surface area of 2500 ft^2. Each electrical resistance heating treatment cell (forming an isosceles triangle with 17-ft sides) has a surface area of 125 ft^2; thus, the treatment system for each 50 × 50 ft grid averages 20 electrical resistance heating treatment cells. (Note that each 50 × 50 ft grid cell area contains 15 complete electrical resistance heating treatment cells and 13 partial electrical resistance heating treatment cells.)

Cost-to-Benefit Analysis

This analysis assumes that each characterization boring has the potential value of the cost of installation and operation of five electrical resistance heating treatment cells.

Four soil borings are required to characterize each 50 × 50 ft grid cell.

Twenty electrical resistance heating treatment cells are required for each 50 × 50 ft grid cell.

Thus, if a characterization boring demonstrated the absence of TCE-in-soil, 5 electrical resistance heating treatment cells (20 treatment cells divided by 4 borings) would not be required.

The total area of the treatment zone in the Characterization Plan is 0.5 acres (21,780 ft^2). Given that each electrical resistance heating treatment cell has an area of 125 ft^2, the treatment zone will require approximately 174 treatment cells. The total cost estimated for installation, operation and maintenance, and decommissioning of the electrical resistance heating treatment network is approximately $32,000,000 (DOE 2004); thus, on average, each electrical resistance heating treatment cell costs $183,700.

The initial characterization of the treatment zone is planned to consist of 46 soil borings, which average an estimated cost of \$75 per ft[8] for the soil boring, MIP "sampling," and abandonment of the soil boring. The average characterization boring costs \$6,900 (excluding the cost of mobilization/demobilization and the costs of plans and reporting).

For those characterization borings that document that remediation of an area is not required (decreasing the number of electrical resistance heating treatment cells by five), the benefit to DOE of sampling the boring is \$918,500 (the cost of installation and operation of five electrical resistance heating treatment cells); thus, each \$1 spent in characterization is potentially worth \$130 in saved remediation cost.

[8] The estimated rate of \$75 per ft for the MIP borings includes overhead costs applied at PGDP. Note that this estimate does not include all costs specific to field work at PGDP (e.g., independent safety and health officer, waste management, etc.) and is for comparison, only.

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6. DATA MANAGEMENT

The Data Management Implementation Plan (DMIP) for this RDSI is included as Appendix B of this Characterization Plan. The DMIP identifies and documents data management requirements and applicable procedures, expected data types and flow, and roles and responsibilities for all data management activities associated with the RDSI.

All historical data used in the assessment of the south C-400 block were downloaded from Paducah's Oak Ridge Environmental Information System (Paducah OREIS). Paducah OREIS is the centralized, standardized, quality assured, and configuration-controlled data management system that is the long-term repository for environmental data (measurements and geographic) for all environmental management projects. These activities are represented in the dataset.

- ESO 16906: 1988 initial sampling from discovery of TCE Leak Site
- Phase I and II Site Investigations
- Special underground storage tank/chromium sampling
- WAG 6 RI
- Six-Phase Heating Treatability Study (pre-, final- and post-event sampling)
- PGDP Groundwater Monitoring Program
- Natural Attenuation Project.

The software, *Spatial Analysis and Decision Assistance (SADA)*, (UTK 2002) was used to segregate the available soil and groundwater analyses for discrete depth intervals and to display the data for analysis.

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7. DOCUMENTATION

Field documentation will be maintained throughout the RDSI in various types of documents and formats, including field logbooks and field data sheets. The following general guidelines for maintaining field documentation will be implemented. Additional information is contained in the QAPP (Appendix A) and DMIP (Appendix B). All entries will be written clearly and legibly using indelible ink.

- Corrections will be made by striking through the error with a single line that does not obliterate the original entry. Corrections will be dated and initialed.

- Dates and times will be recorded using the format "mm/dd/yy" for the date and the military (i.e., 24-hr) clock to record the time.

- Zeroes will be recorded with a slash (/) to distinguish them from letter Os.

- Blank lines are prohibited. Information should be recorded on each line or the line should be lined out, initialed, and dated.

- No documents will be altered, destroyed, or discarded even if they are illegible or contain inaccuracies that require correction.

- All information blocks on field data forms will be completed or a line will be drawn through the unused section, and the area will be dated and initialed.

- Unused logbook pages will be marked with a diagonal line drawn from corner to corner and a signature and date must be placed on the line.

- Security of all logbooks will be maintained by storing them in a secured (e.g., locked) area when not in use.

- Photocopies of all logbooks, field data sheets, and chain-of-custody (COC) forms will be made weekly and sent to the project file.

7.1 FIELD PLANNING MEETING

A field-planning meeting will occur before work begins at the site so that all involved personnel will be informed of the requirements of the fieldwork associated with the project. Additional planning meetings will be held whenever new personnel join the field team or if the scope of work changes significantly. Each meeting will have a written agenda and attendees must sign an attendance sheet, which will be maintained on-site and in the project files. The following topics will be discussed at these meetings:

- project- and site-specific health and safety,
- objectives and scope of the fieldwork,
- equipment and training requirements,
- procedures,
- required QC measures, and
- documents covering on-site fieldwork.

7.2 READINESS CHECKLIST

Before implementation of the field program, all project personnel will review the work control documents to identify all field activities and materials required to complete the following requirements:

- task deliverables,
- required approvals and permits,
- personnel availability,
- training,
- field equipment,
- sampling equipment,
- site facilities and equipment, and
- health and safety equipment.

Before fieldwork begins, appropriate DOE Prime Contractor personnel will concur that readiness has been achieved.

7.3 FIELD LOGBOOKS

Field team personnel will use bound field logbooks with sequentially numbered pages for the maintenance of field records and for documenting any information pertinent to field activities. Field forms will be numbered sequentially or otherwise controlled. A designated field team member will record sampling activities and information from site exploration and observation in the field logbook. Field documentation will conform to approved procedures for use of field logbooks. An integral component of Quality Assurance (QA)/QC for field activities will be the maintenance of accurate and complete field records and the collection of appropriate field data forms. The primary purpose of the logbook is to document each day's field activities; the personnel on each sampling team; and any administrative occurrences, conditions, or activities that may have affected the fieldwork or data quality of any characterization or environmental samples for any given day. The level of detail of the information recorded in the field logbook should be such that an accurate reconstruction of the field events can be created from the logbook. The project name, logbook number, client, contract number, task number, document control number, activity or site name, and the start and completion dates will be listed on each logbook's front cover. Important phone numbers, radio call numbers, emergency contacts, and a return address should be recorded on the inside of the front cover.

7.4 SAMPLE LOG SHEETS

Sample log sheets will be required only for waste characterization samples. A sample log sheet will contain sample-specific information for each field sample collected, including field QC samples. Generally, sample log sheets will be preprinted from the data management system with the following information:

- name of sampler;
- project name and number;
- sample identification number;
- sampling location, station code, and description;
- sample medium or media;
- sample collection date;

- sample collection device;
- sample visual description;
- collection procedure;
- sample type;
- analysis; and
- preservative.

In addition, all specific analytical requests will be preprinted from the data management system and will include the following for each analytical request:

- analysis/method,
- container type,
- number of containers,
- container volume,
- preservative (type/volume), and
- destination laboratory.

During sample collection, a field team member will record the remaining required information and will sign and date each sample log sheet. The following information will be recorded for each sample:

- whether or not the sample was collected;
- the date and time of collection;
- the name of the collector;
- collection methods and/or procedures;
- all required field measurements and measurement units;
- instrumentation documentation, including the date of last calibration;
- adherence to or deviation from the procedure and the SI Characterization Plan;
- weather conditions at the time of sample collection;
- activities in the area that could impact subsequent data evaluation;
- general field observations that could assist in subsequent data evaluation;
- lot number of the sample containers used during sample collection;
- sample documentation and transportation information, including unique COC form number, air bill number, and container lot number; and
- all relevant and associated field QC samples (for each sample).

If preprinted sample log sheets are not used, all information will be recorded manually. A member of the field sampling team (other than the recorder) will perform a QA review of each sample log sheet and document the review by signing and dating the log sheet. Notations of deviations will be initialed by the Field Operations Manager as part of his/her review of the logbook.

7.5 FIELD DATA SHEETS

Field data sheets will be maintained, as appropriate, for the following types of data:

- sample log sheets,
- COCs, and
- instrument calibration logs.

Data to be recorded will include such information as the station name, sample matrix, sample type, and applicable sample analysis to be conducted. Field-generated data forms will be prepared, if necessary, based on the appropriate requirements. The same information may be included in the field logbook or, if not, the field logbook should reference the field data sheet. If preprinted field data sheets are not used, all information will be recorded manually in the field logbook.

7.6 SAMPLE IDENTIFICATION, NUMBERING AND LABELING

In addition to field logbooks and field data sheets, the waste characterization sampling team will use labels to track sample holding times, ensure sample traceability, and initiate the COC record for the waste characterization samples. A pressure-sensitive gummed label will be secured to each sample container at the time of collection, including duplicates and trip or field blanks, at or before the completion of collection of that sample. Sample labels will be waterproof or will be sealed to the sample container with clear acetate tape after all information has been written on the label. Generally, sample labels will be preprinted with information from the data management system and will contain the following information:

- station name ("WASTE"),
- sample identification number,
- sample matrix,
- sample type (grab or composite),
- type or types of analysis required,
- sample preservation (if required), and
- destination laboratory.

A field sampling team member will complete the remaining information during sample collection including these items:

- date and time of collection, and
- initials of sampler.

The sample numbers will be recorded in the field logbook along with the time of collection and descriptive information previously discussed.

The sample identification protocol is outlined as follows:

rrrrrrrMA000

where

rrrrrrr	identifies the waste management request for disposal (RFD);
M	identifies the media type (W identifies the sample as waste water, S identifies the sample as soil);
A	identifies the sequential sample (usually "A" for a primary sample and "B" for a secondary sample); and
000	identifies the sequential sample for the RFD.

7.7 SAMPLE STORAGE

Samples are to be properly preserved, packaged, and delivered to the laboratory under adequate COC. Several procedures may exist to define requirements for sample storage:

- *Quality Assured Data*,
- *Field Logbooks*,
- *Chain-of-Custody*,
- *Data Management Coordination*, and
- *Sample Tracking and Handling Guidance*.

Soil and water samples for laboratory analysis must be stored on-site until a radiological survey of the exterior of the sample containers releases the samples for off-site shipment. Typical COC protocol requires that environmental samples physically be kept in the presence of the sample custodian or in a secured facility with access control prior to delivery or shipment of the samples to the analytical laboratory. Where the samples must be maintained at 4°C for sample preservation (a common requirement), a calibrated (National Institute of Standards and Technology-traceable) thermometer will be used to monitor the temperature inside the sample storage container (ice chest or refrigerator). The sample custodian will document the temperature inside the sample storage container in a log of daily inspections.

7.8 SAMPLE COC

COC procedures will document sample possession from the time of collection, through all transfers of custody, to receipt at the laboratory and subsequent analysis. COC records will accompany each packaged lot of samples; the laboratory will not analyze samples that are not accompanied by a correctly prepared COC record. A sample will be considered under custody if it is (1) in the possession of the sampling team, (2) in view of the sampling team, or (3) transferred to a secured (i.e., locked) location.

COC records will follow the requirements as specified in a DOE Prime Contractor-approved procedure for keeping records. This form will be used to collect and track samples from collection until transfer to the laboratory. Copies of the signed COCs will be faxed or delivered to the DOE Prime Contractor Sample Management Office within three days of sample delivery.

The Sampling Team Leader is responsible for reviewing and ensuring the accuracy and completeness of the COC form and for the custody of samples in the field until they have been properly transferred to the Sample Coordinator. He or she is responsible for sample custody until the samples are properly packaged, documented, and released to a courier or directly to the analytical laboratory. If samples are not immediately transported to the analytical laboratory, they will remain in the custody of the Sample Coordinator where they will be refrigerated and secured either by locking the refrigerator or by placing custody seals on the individual containers.

Each COC form will be identified by a unique number located in the upper-right corner, recorded on the sample log sheet at the time of sample collection. The laboratory COC will be the "official" custody record for the samples. Each COC form will contain the following information:

- the sample identification for each sample;
- collection data for each sample;
- number of containers of each sample;
- description of each sample (i.e., environmental matrix/field QC type);

- analyses required for each sample; and
- blocks to be signed as custody is transferred from one individual to another.

The air bill number will be recorded on the COC form if applicable. The laboratory COC form will be sealed in a resealable plastic bag and taped to the inside of the cooler lid if the samples are to be shipped off-site. A copy will be retained in the laboratory, and the original will be returned to the Sample Manager with the completed data packages.

At each point of transfer, the individuals relinquishing and receiving custody of the samples will sign in the appropriate blocks and record the date and time of transfer. When the laboratory sample custodian receives the samples, he or she will document receipt of the samples, record the time and date of receipt, and note the condition of the samples (e.g., cooler temperature, whether the seals are intact) in the comments section. The laboratory then will forward appropriate information to the Sample Manager. This information may include the following:

- a cover memo stating sample receipt date and any problems noted at the time of receipt; and

- a report showing the field sample identification number, the laboratory identification number, and the analyses scheduled by the laboratory for each sample.

7.9 SAMPLE SHIPMENT

An on-site laboratory will screen aliquots of waste management samples before shipment to an off-site laboratory. Results from the screening process will be recorded in Paducah's Project Environmental Measurements System and will be reviewed prior to preparation for sample shipment off-site. Sample containers will be placed in the shipping container and packed with ice and absorbent packing for liquids. The completed COC form will be placed inside the shipping container unless otherwise noted. The container then will be sealed. In general, sample containers will be packed according to the following procedures.

- Glass sample containers will be wrapped in plastic insulating material to prevent contact with other sample containers or the inner walls of the container.

- Logbook entries, sample tags and labels, and COC forms will be completed with sample data collection information and names of all persons handling the sample in the field before packaging.

- Samples, temperature blanks, and trip blanks will be placed in a thermally-insulated cooler along with ice that is packed in resealable plastic bags. After the cooler is filled, the appropriate COC form will be placed in the cooler in a resealable plastic bag attached to the inside of the cooler lid.

- Samples will be classified according to U.S. Department of Transportation (DOT) regulations pursuant to 49 *CFR* 173. All samples will be screened for radioactivity to ensure that DOT limits of 2.0 nCi/ml of liquid waste and 2.0 nCi/g for solid waste are not exceeded.

8. WASTE MANAGEMENT AND DISPOSITION

PGDP waste management practices for the activities below will follow DOE Prime Contractor-approved procedures during the implementation of the RDSI:

- Off-Site Decontamination Pad Operation, (if applicable)
- Pumping Liquid Wastes Into Tankers,
- Sampling of Containerized Waste, and
- Opening Containerized Waste.

The Remedial Design Subcontractor is responsible for developing a WM/DP for the RDSI.

8.1 LISTED WASTE

The RDSI drilling wastes will include drill cuttings and water from the UCRS within SWMUs with known TCE contamination and from the RGA within the known TCE plumes. Because most of the drilling will take place where the concentration of TCE is highest at PGDP, the environmental media waste generated will be either hazardous (above health-based levels) or subject to a contained-in determination (solids with TCE levels less than 39.2 ppm or aqueous solutions less than 81 ppb) or exempted from the definition of hazardous waste (purge water and well development water with TCE levels less than 1 ppm). Likewise, decontamination water and sludge (soil sediments/mud) from equipment used to install portions of the borings may contain similar contamination. Most of the PPE, plastic, and other drilling-generated waste will require either decontamination or disposal as hazardous waste.

As such, these wastes have the potential to contain contaminants related to known or suspected past operational or disposal practices; therefore, this waste must be managed as hazardous until waste sample analytical results are received from the laboratory and the waste can be determined to be either non-hazardous, subject to a "No-Longer-Contains" determination, or RCRA-listed hazardous. Upon the completion of waste characterization, the waste must be stored and disposed of in accordance with applicable state and federal guidelines.

RFD documentation will be prepared by the RDSI Subcontractor for all waste. The WM/DP, to be prepared by the RDSI Subcontractor, will specify the types of containers that will be used for the storage of waste. These containers must meet waste container requirements of the DOE Prime Contractor. Waste will be accumulated in a CERCLA Storage Area. (The RDSI Subcontractor must obtain approval for the location of the CERCLA Storage Area from the DOE Prime Contractor.) Water will be treated at C-612, C-752-C, or other acceptable facility and discharged to a Kentucky Pollutant Discharge Elimination System outfall. The solids will be transferred to a proper storage area.

8.2 ANTICIPATED WASTE STREAMS

The RDSI will result in several waste streams to be managed during the field operation. The following wastes are anticipated to be included among the project waste streams:

- miscellaneous noncontaminated construction waste (office paper, aluminum cans, packaging materials, and glass bottles not used to store potentially hazardous chemicals, aluminum foil, and food items);

- staging area waste (plastic and packaging materials);
- MIP probe waste (PPE and plastic, purge water, soil cuttings, and excess grout);
- MIP analytical waste (used and excess calibration standards, plastic tubing, PPE, paper);
- decontamination waste (PPE, plastic, water, and sludge); and
- miscellaneous waste (Health and Safety generated waste, returned Health and Safety monitoring samples, returned waste characterization samples).

9. SURVEYING SAMPLE LOCATIONS

The MIP boreholes will be located in the field according to the Sampling Plan to facilitate issuance of an Excavation/Penetration Permit for the boreholes and for reference during design and placement of the heating electrode grid. Each sample point will be located for its horizontal and vertical location using the PGDP coordinate system for horizontal control. The datum for vertical control will be the U.S. Coast and Geodetic Survey North American Vertical Datum of 1988. Horizontal and vertical accuracy for this work will be at least ± 1 ft, but must be sufficient to support the design of the follow-on heating electrode grid. Potential methods to locate the MIP boreholes include tape and compass measurements off features with known PGDP coordinates (e.g., the centerlines of streets), use of a global positioning satellite receiver (note that a permit will be required from PGDP Security to transport and use the receiver on-site), or civil survey. A thorough description of each location will be made during fieldwork and will be documented using field maps.

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APPENDIX A

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN

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ABBREVIATIONS AND ACRONYMS

ASTM	American Society for Testing and Materials
CFR	*Code of Federal Regulations*
COC	chain-of-custody
DMIP	Data Management Implementation Plan
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	Data Quality Objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ES&HP	Environmental, Safety, and Health Plan
FCR	Field Change Request
FOM	Field Operations Manager
GC	gas chromatograph
MDL	method detection limit
MIP	Membrane Interface Probe
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NCR	Nonconformance Report
ND	not detected
NIST	National Institute of Standards and Technology
Paducah OREIS	Paducah's Oak Ridge Environmental Information System
Paducah PEMS	Paducah's Project Environmental Measurements System
PARCC	precision, accuracy, representativeness, completeness, and comparability
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RDSI	Remedial Design Support Investigation
SOP	Standard Operating Procedure
STR	Subcontract Technical Representative
SVOC	semivolatile organic compound
TCE	trichloroethene
VOC	volatile organic compound
WM/DP	Waste Management and Disposition Plan

QA/R-5 AND QAMS-005 LOCATOR PAGE

QA/R-5	QAMS-005/80	Section Number and Title in Quality Assurance Plan
A1 Title Page and Approval Sheet	1.0 Title Page with Provision for Approval Signatures	Approval Page
A2 Table of Contents	2.0 Table of Contents	Contents
A3 Distribution List		Distribution List
A4 Project/Task Organization	4.0 Project Organization and Responsibility	2 Project QA Responsibility
A5 Project Definition/Background A6 Project/Task Description	3.0 Project Description	1 Project Description
A7 Quality Objectives and Criteria	5.0 QA Objectives for Measurement (PARCC)	5 QA Objectives for Measurement of Data
A8 Special Training/Certification	4.0 Project Organization and Responsibility	3 Personnel Qualifications and Training
A9 Documents and Records	4.0 Project Organization and Responsibility	4 Document Control and Records Management
B1 Sampling Process Design B2 Sampling Methods	6.0 Sampling Procedures	6 Sampling Procedures
B3 Sample Handling and Custody	7.0 Sample Custody	7 Sample Custody
B4 Analytical Methods	9.0 Analytical Procedures	9 Analytical Procedures
B5 Quality Control	11.0 Internal Quality Control Checks and Frequency	11 Internal Quality Control Checks
B6 Instrument/Equipment Testing, Inspection, and Maintenance	13.0 Preventative Maintenance	13 Preventive Maintenance
B7 Instrument/Equipment Calibration and Frequency	8.0 Calibration Procedures and Frequency	8 Instrument Calibration and Frequency
B8 Inspection/Acceptance of Supplies and Consumables		17. Inspection of Materials
B9 Non-direct Measurements	10.0 Data Reduction, Validation, and Reporting	10 Data Review and Reporting
B10 Data Management	10.0 Data Reduction, Validation, and Reporting	10 Data Review and Reporting
C1 Assessment and Response Actions	12.0 Performance and Systems 15.0 Corrective Action	12 Audits and Surveillances
C2 Reports to Management	16.0 QA Reports to Management	15 QA Reports to Management 16 Field Changes
D1 Data Review, Verification, and Validation D2 Verification and Validation Methods	10.0 Data Reduction, Validation, and Reporting	10 Data Review and Reporting
D3 Reconciliation with User Requirements	14.0 Specific Routine Procedures Measurement Parameters Involved	14 Reconciliation with User Requirements

10 *CFR* 830.120 LOCATOR PAGE

The following 10 quality assurance (QA) elements are discussed in 10 *CFR* 830.120. This locator is a crosswalk between those 10 elements and the related sections of the governing QA documents for the C-400 Remedial Design Support Investigation at the Paducah Gaseous Diffusion Plant (PGDP).

	C-400 Remedial Design Support Investigation Characterization Plan
10 *CFR* 830.120 Element	**Project Reference**
1. Management (i) Program	To be determined based upon DOE Prime Contractor-approved quality documents.
1. Management (ii) Personnel Training and Qualification	To be determined based upon DOE Prime Contractor-approved quality documents.
1. Management (iii) Quality Improvement	To be determined based upon DOE Prime Contractor-approved quality documents.
1. Management (iv) Documents and Records	To be determined based upon DOE Prime Contractor-approved quality documents.
2. Performance (i) Work Processes	To be determined based upon DOE Prime Contractor-approved quality documents.
2. Performance (ii) Design	To be determined based upon DOE Prime Contractor-approved quality documents.
2. Performance (iii) Procurement	To be determined based upon DOE Prime Contractor-approved quality documents.
2. Performance (iv) Inspection and Acceptance Testing	To be determined based upon DOE Prime Contractor-approved quality documents.
3. Assessment (i) Management Assessment	To be determined based upon DOE Prime Contractor-approved quality documents.
3. Assessment (ii) Independent Assessment	To be determined based upon DOE Prime Contractor-approved quality documents.

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A.1. PROJECT DESCRIPTION

This Quality Assurance Project Plan (QAPP) has been developed specifically for the C-400 Remedial Design Support Investigation (RDSI) at the Paducah Gaseous Diffusion Plant (PGDP). Following is the problem statement for this investigation.

> *Existing characterization data for the south C-400 area, notably data from the WAG 6 RI, delineate a zone of soil and groundwater in the UCRS and RGA that is contaminated by high concentrations of TCE that are indicative of the presence of DNAPL. Other VOCs are known to be present. Optimal placement of a remediation system requires further characterization of the magnitude of the existing levels of total VOCs and the extent of the zone of highest contaminated soils and groundwater.*

This investigation will utilize screening methodology to better define the major source areas of contamination at the C-400 Cleaning Building in order to better target multiphase electrical heating for the interim remedial action at the C-400 Cleaning Building.

Work for this investigation will be performed in accordance with this QAPP (approved by the U.S. Department of Energy [DOE] Prime Contractor). This QAPP is prepared in accordance with the U.S. Environmental Protection Agency's (EPA's) QA/R-5 *EPA Guidance for Quality Assurance Project Plans*, EPA/240/B-01/003, March 2001; and 10 *CFR* 830.120. In addition, a crosswalk table has been provided that shows the relationship to EPA's QAMS-005/80, 1983. The DOE Prime Contractor Quality Assurance (QA) Specialist, who will maintain QA oversight throughout the project, reviews this QAPP for QA/Quality Control (QC) requirements.

A.2. PROJECT ORGANIZATION

Roles and responsibilities of the project team are detailed in Table A.1.

Adherence to the QA/QC requirements in this QAPP will require coordination and integration between QA representatives from the DOE Prime Contractor and Subcontractor. The roles and responsibilities for the Subcontractor QA representatives are discussed in Table A.1. The Subcontractor's QA Coordinator will assume responsibility for day-to-day QA activities associated with the investigation project and all QA issues related to the Subcontractor's QA program. The Subcontractor's QA Manager also will be responsible for all coordination with the DOE Prime Contractor QA Specialist. The DOE Prime Contractor QA Specialist will provide QA oversight and coordination with DOE and the regulatory agencies on all QA issues.

Table A.1. Roles and Responsibilities

Role	Responsibility
DOE Project Manager	Responsible for project oversight.
DOE Prime Contractor Project Manager	Responsible programmatically for technical, financial, and scheduling matters; will interface with the DOE and regulators, as appropriate.
DOE Prime Contractor Subcontract Technical Representative (STR)	Responsible for management and integration of subcontractor implementation of this investigation.
Subcontractor Program Manager	Ensures overall quality of subcontractor's projects under the general order contract; ensures project goals and objectives are met in a high-quality, timely manner; responsible for allocating resources throughout the project, communicating with the DOE Prime Contractor.
Subcontractor Team Project Manager	Responsible for implementing the investigation, including all plans and field activities conducted as part of the support investigation including monitoring the performance of sampling and waste management and disposition activities; serves as the technical lead and principle point of contact with the Program Manager and STR; tracks project budget and schedules and delegates specific responsibilities to project team members; responsible for preparing any field change orders.
Subcontractor Team Site Environmental, Safety, and Health Representative	Ensures that health and safety procedures designed to protect personnel are maintained throughout the field effort for this project; ensures the implementation of an Integrated Safety Management System for all aspects of the Support Investigation.
Subcontractor Team QA Manager	Provides QA oversight and approval for the project; conducts audits and surveillances and approves any field changes that may impact the project quality.
Subcontractor Team QA Coordinator	Provides QA oversight for all day-to-day QA activities associated with the investigation project and all QA issues related to the Subcontractor's QA program.
Subcontractor Team Field Operations Manager	Provides technical oversight for all field team activities during the investigation.
Subcontractor Team Lower-Tier Subcontractors	Responsible for providing the labor and expertise in conducting the investigation.
Subcontractor Team Waste Management Coordinator	Ensures adherence to the Waste Management and Disposition Plan (WM/DP); documents and tracks field-related activities, including waste generation and handling, waste characterization sampling, waste transfer, and waste labeling.
Subcontractor Team Sample Management Coordinator	Responsible for coordinating sampling activities, including coordination with the DOE Prime Contractor sample management office; ensures all quality control sampling requirements are met, chain-of-custody (COC) forms are properly generated, and compliance with off-site shipping requirements is achieved.
Subcontractor Team Data Coordinator	Responsible for managing data generated during the investigation in accordance with the Data Management Implementation Plan (DMIP).

A.3. PERSONNEL QUALIFICATIONS AND TRAINING

Personnel assigned to the project, including field personnel and subcontractors, will be qualified to perform the tasks to which they are assigned. Resumes of project personnel will be provided to the DOE Prime Contractor to document their training and experience. In addition to education and experience, specific training may be required to qualify individuals to perform certain activities. Training will be documented on appropriate forms, which will be placed in the project file. Project personnel will receive an orientation to the RDSI Characterization Plan, the RDSI Environmental, Safety, and Health Plan (ES&HP), the RDSI WM/DP, and this QAPP, as well as to their responsibilities, before participating in project activities. A field-planning meeting will be the forum for the orientation. All field personnel will be required to read and familiarize themselves with the RDSI Characterization Plan, the QAPP, the RDSI

WM/DP, and the RDSI ES&HP before performing any work at the site. All sampling activities will be performed in compliance with the RDSI Characterization Plan. A copy of the following documents will be available to all field personnel while in the field.

- RDSI Characterization Plan, including the QAPP and the DMIP
- RDSI WM/DP
- RDSI Site-Specific ES&HP

At a minimum, records of required reading reports and attendance lists will be maintained.

Training will be conducted in accordance with DOE Prime Contractor-approved procedures. A training profile (required training for each work assignment) will be established for each individual. Changes in controlled documents will be monitored and training assignments will be issued to individuals as changes occur.

A.4. DOCUMENT CONTROL AND RECORDS MANAGEMENT

Document control and records management plans are addressed in Appendix B.

A.5. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

A5.1 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problems being investigated. DQOs also establish numeric limits to ensure that data collected are of sufficient quality and quantity for user applications. The principal study questions and decision statements for this investigation are located in the RDSI Characterization Plan.

A5.2 DATA CATEGORIES

Two descriptive data categories have been specified by EPA in *Data Quality Objectives Process for Superfund*, Interim Final Guidance, EPA/540/G-93/071, 1993. These two data categories supersede the five QC levels (Levels I, II, III, IV, and V) defined in EPA's *Data Quality Objectives for Remedial Response Activities, Development Process*, 1987. The two new data categories are associated with specific QA/QC elements and may be generated using a wide range of analytical methods. The two data categories are described below.

- **Screening data with definitive confirmation:** Screening data provide analyte identification and quantification using rapid, less precise analytical methods than definitive data. The primary difference between screening data and definitive data is the level of QA/QC required. The QA/QC requirements for screening data are as follows:

- sample documentation (location, date and time collected, batch, etc.);
- sample COC (when appropriate);
- sampling design approach;
- initial and continuing calibration;
- determination and documentation of detection limits;
- identification of compounds and analytes detected;
- quantification of compounds and analytes detected;
- analytical error determination; and
- definitive confirmation.

At least 10% of the screening data must be confirmed with definitive data in order to be recognized as being of known data quality. Screening data without definitive confirmation will be utilized in this project for the MIP analysis. This information will be used to qualitatively determine the extent of the zone of highest contaminated soils and groundwater.

- **Definitive data:** Definitive data are generated using EPA-approved or other nationally recognized analytical methods. Data are compound- or analyte-specific; the identity and concentration of the analyte are confirmed. Data can be generated on-site or at an off-site fixed-base laboratory as long as the following QA/QC elements are satisfied:

  - sample documentation (location, date and time collected, batch, etc.);
  - sample COC (when appropriate);
  - sampling design approach;
  - initial and continuing calibration;
  - determination and documentation of detection limits;
  - identification of compounds and analytes detected;
  - quantification of compounds and analytes detected;
  - QC blanks (trip, method, equipment rinsates);
  - matrix spike (MS) recoveries;
  - analytical error determination (measures precision of analytical method); and
  - total measurement error determination (measures overall precision of measurement system from sample acquisition through analysis).

Definitive data will be collected and analyzed in a fixed-base laboratory when the waste from the RDSI is sampled for characterization. Field measurements collected during the RDSI will be measured in the field using appropriate field instruments. Table A.2 summarizes the data uses, data users, data categories, and data deliverable QC levels for each of the media and sample types that will be collected during this investigation.

Table A.2. Data uses and QC levels

Field Activity/ Media	Intended Uses	Intended Users[a]	Data Category
Health and safety monitoring	• Determination of appropriate protection levels for field personnel • Determination of well development completion	Field personnel Project Technical Support	None specified
Field Measurements	• Screening soil and groundwater samples with a gas chromatograph for VOCs with MIP soil sample collection	Project Manager Field Personnel Project Technical Support	Screening
	• Screening samples for radiation before off-site shipment	Project Manager Field Personnel Project Technical Support	Screening with definitive confirmation
Waste Sampling	• Characterization of waste for proper transport and disposal	Project Manager Technical support staff	Definitive

MIP = Membrane Interface Probe
VOCs = volatile organic compounds

A5.3 INTENDED USES OF ACQUIRED DATA

The intended uses of the acquired data are to determine the following:

- Scientific data generated will be of sufficient quality to withstand scientific and legal scrutiny.
- Data will be gathered or developed in accordance with procedures appropriate for its intended use. All laboratory methods/procedures specified for this project will comply with EPA requirements for Comprehensive Environmental Response, Compensation, and Liability Act investigations.
- Data will be of known precision, accuracy, representativeness, completeness, and comparability (PARCC) within the limits of the project. Specific criteria for PARCC parameters have been established, as appropriate.

A5.4 INTENDED USERS OF DATA

The primary users of the data acquired during the support investigation will be the following groups or organizations.

- The Project Team will use the MIP data to better define the area of high contaminant levels/ dense nonaqueous-phase liquid (DNAPL) at the southern end of the C-400 Cleaning Building.
- The Project Team will use the waste sampling analytical data to characterize project-derived waste for disposal.
- The data management team will add these data to Paducah Oak Ridge Environmental Information System (Paducah OREIS), as appropriate.

A5.5 PARCC PARAMETERS

PARCC parameters are tools by which data sets can be evaluated. Evaluation of PARCC parameters helps ensure that DQOs are met. Table A.3 displays QA objectives for laboratory measurements for waste samples.

Table A.3. QA objectives for fixed-base laboratory measurements

Parameter	Method	Matrix	Precision[a]	Accuracy	Completeness
VOCs	SW-846[a] 8260	Water	13%	80 – 100%	90%
VOCs	SW-846[a] 8260	Soil	13%	80 – 100%	90%
SVOCs	SW-846[a] 8270	Water	13%	80 – 100%	90%
SVOCs	SW-846[a] 8270	Soil	13%	80 – 100%	90%
Polychlorinated Biphenyls	SW-846[a] 8080	Water	13%	80 – 100%	90%
Polychlorinated Biphenyls	SW-846[a] 8080	Soil	13%	80 – 100%	90%
Radionuclides	Lab-specific	Water	50%	80 – 100%	90%
Radionuclides	Lab-specific	Soil	50%	80 – 100%	90%
Metals	SW-846 6010 and 7000 series	Water	20%	80 – 100%	90%
Metals	SW-846 6010 and 7000 series	Soil	20%	80 – 100%	90%

Precision and accuracy values shown for radionuclides represent levels of 15 pCi/L and 15 pCi/g and above. Lower levels will have substantially wider precision and accuracy limits.

[a]EPA 1994. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Second Edition, Final Update II, SW-846, September.

SVOCs = semi-volatile organic compounds VOCs = volatile organic compounds

Precision refers to the level of agreement among repeated measurements of the same characteristic, usually under a given set of conditions. To determine the precision of the laboratory analysis, a routine program of replicate analyses is performed. Duplicate field samples will be collected to determine total measurement (sampling and analytical) precision. The precision of field instrument measurements will be based on manufacturers' data (see Table A.4).

Table A.4. QA objectives for field measurements

Parameter	Matrix	Accuracy	Precision	Completeness
Total organic vapors (air monitoring)	Gas	ND[a]	—[b]	90%
Radiation health and safety (monitoring)	Aqueous, solid	ND	—[b]	90%
VOCs (determined by the GC)	Groundwater	ND	ND	90%
VOCs (determined by the GC)	Soil	ND	ND	90%

[a]Independent accuracy checks will not be determined in the field. Accuracy varies according to the type of instrument used. Instruments will be calibrated daily, or more frequently as specified in the manufacturers' guidelines. (See Chap. 8 of this QAPP for further information on equipment calibration procedures.)

[b]Direct reading instrument, incapable of reproducing a value without an air standard because atmospheric concentration varies and is unknown. Users will rely on calibration results to verify proper functioning of instrument.

GC = gas chromatograph
ND = not determined
VOCs = volatile organic compounds

Accuracy refers to the nearness of a measurement to an accepted reference or true value. To determine the accuracy, the evaluation is applied over the entire range of concentrations. To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted (minimum 1 spike and 1 spike duplicate per 20 samples).

In addition, a Laboratory Control Sample will be performed for each batch and plotted on control charts. Accuracy of the Laboratory Control Sample will be evaluated in accordance with laboratory statistical guidelines.

Accuracy and precision of data collected in the investigation will depend on the measurement standards used and their meticulous, competent use by qualified personnel. Objectives for laboratory accuracy and precision for this project are shown in Tables A.3 and A.4. The compound-specific precision and accuracy objectives will be included in the laboratory QAPP and will be reviewed for appropriateness. Accuracy of field instruments will not be determined; however, frequent calibration and operational checks will be performed (see Sect. A.8.1 of this QAPP) to ensure the accuracy of instrument measurements.

Representativeness is the degree to which discrete samples accurately and precisely reflect a characteristic of a population, variations at a sampling location, or an environmental condition. Representativeness is a qualitative parameter and will be achieved through careful, informed selection of sampling sites, drilling sites, drilling depths, and analytical parameters and through the proper collection and handling of samples to avoid interference and minimize contamination and sample loss.

Completeness is a measure of the percentage of valid, viable data obtained from a measurement system compared with the amount expected under normal conditions. The goal of completeness is to generate a sufficient amount of valid data to satisfy project needs. For this project, the completeness objective for field and laboratory measurements is 90%.

Comparability is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. Comparability will be assessed in terms of field SOPs, analytical methods, QC, and data reporting. In addition, data validation assesses the processes employed by the laboratory that affect data comparability.

A.6. SAMPLING PROCEDURES

Sampling procedures are discussed in the RDSI Characterization Plan. The procedures to be used for this investigation are DOE Prime Contractor-approved procedures.

A.7. SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Sample custody procedures are addressed in the RDSI Characterization Plan.

A.8. INSTRUMENT CALIBRATION AND FREQUENCY

A8.1 FIELD EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCIES

The calibration of field instruments will be checked in the field in accordance with a DOE Prime Contractor-approved procedure. Field calibration records will be documented in logbooks or on field data sheets. Calibration frequency is summarized in Table A.5; an example field calibration record is given in Fig. A.1.

Table A.5. Field equipment and calibration/functional check frequencies

Equipment check frequency	Field usage	Frequency	Calibration/ check	Calibration/ functional material	Calibration check procedure
Hand-held PID	Health and safety	Daily before use	At end of day	Traceable calibration gas	Manufacturer Specifications
Radiation detectors	Field screen, health and safety	Daily before use[a]	At end of day	Alpha, gamma, and beta radioactive sources	Manufacturer Specifications
Combustible gas indicator	Health and safety	Daily before use[a]	At end of day	Traceable methane	Manufacturer Specifications
MIP[b]	Field screen	Daily before use	As specified by MIP contractor	TCE reference standard	Manufacturer Specifications
MIP transfer line and detectors	Field screen	Prior to each run	Check clogging & leakage	Reference standard	Manufacturer Specifications
MIP soil conductivity measurement tip	Field screen	Prior to each run	Excitation voltage of pole	Manufacturer Specification	Manufacturer Specifications

[a] These instruments are calibrated by the manufacturer. A functional check will be conducted daily before use to ensure that the equipment is working.
[b] During use, the MIP requires continuous monitoring of the probe temperature. The probe must operate within a relatively narrow temperature envelope to assure proper response.

EPA = U.S. Environmental Protection Agency
MIP = Membrane Interface Probe
N/A = not applicable
PID = photoionization detector
TCE = trichloroethene

A8.2 LABORATORY EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCIES

The laboratory(ies) will use written, standard procedures for equipment calibration and frequency. These procedures are based on EPA guidance or manufacturers' recommendations and are given in the EPA-approved analytical methods. Supplemental calibration details, such as documentation and reporting requirements, are given in the laboratory QA plan. The laboratory QA plan will be reviewed and approved by the DOE Prime Contractor, as part of the laboratory review process. The appropriate references for all analytical parameters are included in the reference section of this document. When available, standards used for calibration will be traceable by the National Institute of Standards and Technology (NIST). Corrective action procedures for improperly functioning equipment will be addressed in the fixed-base laboratory QA plan. Any calibration failures will be documented with a specific qualifier for the affected results. Calibration records in accordance with the fixed-base laboratory QA plan will be maintained for each piece of measuring and test equipment and each piece of reference equipment. The records will indicate that established calibration procedures have been followed. Records of equipment use will be kept in the fixed-base laboratory files.

CATEGORY 1 M&TE CALIBRATION LOG

IDENTIFIER	ITEM DESCRIPTION	CALIBRATION MEASUREMENT			BACKGROUND CHECK	RESPONSE CHECK	NAME	DATE
		PRE	ADJUSTMENT	POST				

Fig. A.1. Example of an equipment calibration log.

A.9. ANALYTICAL PROCEDURES

This project will use fixed-base laboratory analytical procedures for waste characterization. When available and appropriate for the sample matrix, SW-846 methods will be used. When not available, other nationally recognized methods such as those of EPA, DOE, and the American Society for Testing and Materials (ASTM) will be used. Table A.6 presents field measurement and analytical parameters for all RDSI sampling. Specific compound lists with analytical methods and requirements for fixed-base laboratory analysis will be provided in the project-specific WM/DP.

Table A.6. Analytical parameters

Sample type	Analysis	
	Field measurements	Laboratory analysis
MIP screening measurements	Total organic vapors	Not applicable
Radiation screens for shipment	Not applicable	Laboratory-specific
Waste characterization samples	Not applicable	Refer to the WM/DP

WM/DP = Waste Management and Disposition Plan MIP = Membrane Interface Probe

Method detection limits (MDLs) are the extent to which the equipment or analytical processes can provide accurate, minimum data measurements of a reliable quality for specific constituents. MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The actual quantitation limit for a given analysis will vary depending on instrument sensitivity and matrix effects.

The PGDP analytical laboratory, to meet U.S. Department of Transportation shipping and handling regulations, will perform the screening of waste characterization samples for gross alpha and gross beta. PGDP analytical methods will be followed for these analyses. Analytical sample volume, holding times, and sample containers are provided in Table A.7 for screening analyses.

Table A.7. Analytical methods and sample requirements for screening samples

Parameter	Method no.	Matrix	Holding time	Detection limit	Container	Preservation
Gross alpha and gross beta	Laboratory-specific	Water	6 months	2700 pCi/L	500-mL Boston round glass jar	None
		Soil	6 months	2700 pCi/g	4-oz. wide-mouth glass jar with Teflon-lined lid	None

A.10. DATA REVIEW AND REPORTING

The data reduction, validation, assessment, and reporting for the investigation will be performed in accordance with DOE Prime Contractor-approved procedures. To ensure that data management activities provide an accurate and controlled flow of data generated by the laboratory, it is important that the following data handling and reporting steps be defined and implemented.

A10.1 DATA REDUCTION

Field program data will be produced by means of visual observation, direct-reading instrumentation, and measuring devices. All field activities, direct-reading instruments, and measuring devices will occur or be used in accordance with the Standard Operating Procedures (SOPs) and the specifications in the manufacturers' operations and maintenance manuals, as appropriate.

Field data will not be presented in a report, but will be used as input to the Remedial Action Work Plan. The data recorded in field logbooks and forms will need to be summarized and transferred to tables, figures, maps, or logs. To analyze data, some data will need to be entered into computer databases or onto spreadsheets. The Field Operations Manager (FOM), Field Supervisor, and other team members are responsible for data transfer activities pertinent to their roles on the project. The Project Data/Records Coordinator will ensure that data transfers to the Paducah Project Environmental Management System (Paducah PEMS) are performed accurately.

Data generated by the laboratory will be reduced using the format specified by EPA or other standard methods. The analytical data will be checked for completeness and reasonableness. Laboratory data will be reconciled with field identifiers and will be transferred from the laboratory electronic data deliverable (EDD) to Paducah PEMS. The first two EDDs from each laboratory will be 100% checked against the hard-copy packages. After the first two EDDs from each laboratory are checked, every fifth EDD will be 100% checked.

It will be the responsibility of the Project Data/Records Coordinator to ensure that all data transferred to tables, spreadsheets, logs, maps, figures, or into Paducah PEMS are transferred correctly. All copies (paper and electronic) of data transferred will be checked at least once for completeness and accuracy. All computer programs used to analyze or reduce data will be checked at least once with a data set of known results before the program is used to process data for any site.

A10.2 DATA VERIFICATION, VALIDATION, AND ASSESSMENT

The data review process consists of the verification, validation, and assessment of environmental measurements, waste management data, and analytical data from the fixed-base laboratory. The data verification process determines if results have been returned for all samples, if the proper analytical and field methods have been used, if analyses were performed for the desired parameters, and if the requirements of any laboratory subcontracts have been met. The data validation process determines whether proper QC methods were used and whether the results met established QC criteria. The data assessment process determines whether data are adequate for the intended use. Any problems found during the review process are documented and resolved. Data management information/ requirements for data review are discussed in the DMIP (Appendix B).

A10.2.1 Data Verification

Verification of analytical data can be broken down into two steps, laboratory contractual screening and electronic Paducah PEMS verification. Laboratory contractual screening is the process of evaluating a set of data against the requirements specified in the analytical Statement of Work to ensure that all requested information is received. The contractual screening includes, but is not limited to, the COC, number of samples, analytes requested, total number of analyses, method used, QC samples analyzed, EDDs, units, holding times, and reporting limits achieved. The DOE Prime Contractor Sample Manager is primarily responsible for the screening upon receipt of data from the analytical laboratory. Electronic Paducah PEMS verification is the process for comparing a data set against a set standard or contractual requirement, specific to the project. The Project Data/Records Coordinator performs this electronic verification. Data is flagged, as necessary, and qualifiers are stored in Paducah PEMS for transfer to Paducah OREIS.

Verification of field measurements data consists of establishing that data are recorded correctly and that field instruments have been properly calibrated and ensuring the accuracy and completeness of all field forms and logbooks (e.g., sample information forms, COC forms, requests for samples analysis, etc.). Any problems with the data will be documented, and preventive and possible corrective actions will be taken, if necessary.

A10.2.2 Data Validation

Data validation is the process of screening data and accepting, rejecting, or qualifying the data on the basis of sound criteria. Data validation will be performed in accordance with EPA procedures. Data validation will be performed on 100% of the data package for 5% of the data packages received. DOE Prime Contractor-approved procedures regarding "Data Validation" will be used to validate the data. Data will be validated, as appropriate, based on holding times, initial calibration, continuing calibration, blank results, and other QC sample results. The process includes these steps:

- reviewing data for compliance with contract provisions;
- reviewing data collection and analysis methods for conformance with established criteria such as the RDSI Characterization Plan, the WM/DP, the QAPP, and the latest revision of the EPA SW-846 Test Methods (1994); and
- eliminating obvious errors by checking data for proper sample identification, transmittal errors, internal consistency, and temporal and spatial consistency.

A10.2.3 Data Assessment

The data assessment process will be performed to determine whether the total set of environmental measurements data available to the project satisfies the requirements of the project DQOs. Data assessment will be performed by the RDSI Project Team. The evaluation is concerned with the set of all data collected during a project or phase of a project that is intended for use in characterization, risk assessment, or remedial action decisions.

Waste characterization data must have completed the verification and validation phases before being assessed. The verification and validation of any existing data before assessment is required whenever possible, but the validation activity may not be possible for some existing data, given previous deliverable requirements. All QC data from a project or phase of a project are reviewed to evaluate the quality of the data. The total set of data for the project is reviewed for sensitivity and PARCC parameters.

An integral component of the data assessment process is the comparison of measurement results against the DQOs to determine if the data meet or exceed the "level of certainty" required for decision-making purposes. The field and analytical results are evaluated to see if the requirements determined by the DQO process were met by the sampling and analysis activities. The DOE Prime Contractor STR or designee makes a final determination of the usability of the data. Data qualifiers are assigned to indicate the usability of the data for meeting project requirements.

A10.3 DATA REPORTING

The fixed-base laboratories are required to report data in accordance with applicable DOE or DOE Prime Contractor procedures. Data deliverables will be reported in a format that fulfills the requirements of these procedures. Two copies of each data package will be required. Equivalent information in accordance with these procedures will be reported for radionuclides and other parameters in accordance with these procedures.

For this project, all laboratory analyses will include definitive deliverables. For data presented with definitive deliverables, the laboratory will provide complete data packages that exclude all raw data (formerly Level C). Radionuclide data will include the appropriate uncertainties, measurement statistics, and additional qualifiers necessary to validate data.

A.11. INTERNAL QC CHECKS

SOPs are used for all routine sampling operations. Field QC sampling will be conducted to check sampling and analytical accuracy and precision for laboratory analyses of the original samples. If contaminants are found in the blanks, attempts will be made to identify the source of contamination, and corrective action will be initiated in accordance with Sect. 12.4 of this QAPP. The laboratory analyzing the samples also will include QC samples in accordance with the analytical method and the appropriate DOE or DOE Prime Contractor procedures. These samples will be discussed in the laboratory's QA plan.

The field QC samples and frequencies summarized in this section will be used for this task. All QC samples will be shipped according to the COC procedures specified in the RDSI Characterization Plan. The types of QC samples used in this study are described in the following text.

A11.1 FIELD QC SAMPLES

Field QC samples will have sample numbers as described in the WM/DP.

- A **trip blank** consists of a sealed container of ASTM Type II water that travels from the field to the laboratory with the samples to be analyzed for VOCs. The trip blank receives the same treatment as do sample containers; therefore, it identifies contamination that may have entered the field samples during transport. One trip blank will be placed in each cooler containing samples to be analyzed for VOCs.

- A **field blank** serves as a check on environmental contamination at the sample site. Distilled, deionized water is transported to the site, opened in the field, transferred into each type of sample bottle and returned to the laboratory for analysis of all parameters associated with that sampling event. It also is acceptable for field blanks to be filled in the laboratory, transported to the field, and then opened. Field blanks may be used as a reagent blank, as needed. Field blanks will be collected at a frequency of 1 in 20 samples (5%) for each sample matrix.

- An **equipment blank or rinsate sample** is a sample of deionized water passed through or over decontaminated sampling equipment. Equipment blanks are used as a measure of decontamination process effectiveness and are analyzed for the same parameters as the samples collected with the equipment. Equipment blanks also may be used as reagent blanks, as needed. Equipment blanks are required only when nondisposable equipment is being used. Equipment blanks will be collected at a frequency of 1 in 20 samples (5%).

- One **field duplicate** is collected for every 20 samples (5%) to determine whether the field sampling technique is reproducible. The field duplicate is collected from one sampling location, placed in a separate set of containers, and labeled with a different sample number.

- A **source water blank** is a sample of the deionized and/or potable water sources used for the project. These samples are collected at the beginning of the project and monthly if the project will be of long duration. Source water blanks are used to demonstrate that the source water is not contaminated.

A11.2 ANALYTICAL LABORATORY QC SAMPLES

Analytical laboratory QC samples will be analyzed as required by the analytical method for the parameters of interest; the results will be included in the analytical report.

- **MS/MS duplicate (MSD)** samples require the collection of additional sample volume for aqueous samples. The laboratory splits the samples into duplicates and adds predetermined quantities of stock solutions to them before extraction and analysis. Percent recoveries are calculated to assess accuracy. Relative Percent Differences are calculated to assess analytical precision. MS/MSD samples will be analyzed at a frequency of 1 for every 20 samples (5%) for organic parameters. For inorganic parameters, a laboratory duplicate will be analyzed instead of an MSD.

A.12. AUDITS AND SURVEILLANCES

Audits and surveillances are conducted regularly by DOE Prime Contractor or subcontractor QA staff to do the following:

- check for adherence to the QA/QC requirements specified in the project documents;

- evaluate the procedures used for data collection, data handling, and project management;

- verify that the QA program developed for this project is being implemented according to the specified requirements;

- assess the effectiveness of the QA program; and

- verify that identified deficiencies are corrected.

The DOE Prime Contractor or subcontractor QA Manager is responsible for defining audits and surveillances and will perform or assign them according to a quarterly schedule that coincides with appropriate activities on the project schedule and sampling plans. Scheduled audits and surveillances may be supplemented by additional ones for any of the following reasons:

- significant changes are made in the QAPP,

- it is necessary to verify that corrective action has been taken on a deficiency reported in a previous audit, or

- additional audits or surveillances are requested by the DOE Prime Contractor STR.

A12.1 AUDITS

Audits are performed in accordance with a DOE Prime Contractor-approved procedure. No audits are planned for this task, though periodic field surveillances will be conducted.

A12.2 SURVEILLANCES

Surveillances follow the same general format as an audit, but are less detailed and require a less formal report. A surveillance is designed to give project staff rapid feedback concerning QA compliance and facilitate corrective action.

For this project, one field surveillance is planned shortly after field mobilization. Additional field surveillances will be conducted at critical milestones. The following are example activities and documentation that may be subject to surveillance:

- drilling efforts,
- waste characterization sampling,
- decontamination,
- COC,
- field documentation,
- field training records,
- equipment calibration, and
- field QC procedures.

QA surveillances will be performed in accordance with a DOE Prime Contractor-approved procedure. Problems identified during surveillances will be documented, resolved, and closed in accordance with a DOE Prime Contractor-approved procedure. A DOE Prime Contractor-approved procedure will be used for nonconformances determined to be significant conditions adverse to quality.

Subcontractor's QA Manager may schedule other periodic surveillances. The subcontractor will provide results of the surveillances to the DOE Prime Contractor QA Manager. The surveillances will be integrated between the subcontractor and the DOE Prime Contractor QA Managers to minimize duplication of effort.

A12.3 NONCONFORMANCES

Nonconforming items, services, or processes will be identified, controlled, and reported in accordance with a DOE Prime Contractor-approved procedure. Subcontracting personnel initiate a nonconformance report by completing a Nonconformance Report (NCR), similar to that shown in Fig. A.2. Nonconforming equipment immediately will be labeled or tagged and segregated, if possible.

A12.4 CORRECTIVE ACTION

Each project team member is responsible for notifying the FOM, the Project Manager, the QA staff, or other responsible persons if he/she discovers a condition that may affect the quality of the work being performed. The following staff members have specific corrective action responsibilities.

- **Subcontractor Program Manager**—Overall responsibility for implementing corrective actions.

NONCONFORMANCE REPORT	DATE OF NCR	NCR NUMBER	
	LOCATION OF NONCONFORMANCE		PAGE ____ OF ____
INITIATOR (NAME/ORGANIZATION/PHONE)		FOUND BY	DATE FOUND
RESPONSIBLE ORGANIZATION/INDIVIDUAL			PROGRAM
			PROJECT

DESCRIPTION OF NONCONFORMANCE

CATEGORY: ____ ____ ____ ____ ____

A INITIATOR DATE QA/QC OFFICER DATE CAR REQ'D YES ☐ NO ☐

DISPOSITION:

PROBABLE CAUSE:

ACTIONS TAKEN TO PREVENT RECURRENCE:

B PROPOSED BY: ______________ NAME ______ DATE

JUSTIFICATION FOR ACCEPTANCE

C INITIATOR: ______________ NAME ______ DATE

VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL

REINSPECTION/RETEST REQUIRED YES ☐ NO ☐ IF YES; ______ DATE ______________ RESULT

D QUALITY ASSURANCE: ______________ NAME ______ DATE

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Fig. A.2. Example Nonconformance Report Form.

- **Subcontractor QA Manager**—Overall responsibility for tracking and accepting corrective actions.
- **Subcontractor Project Manager**—Implementing task-specific corrective actions.
- **Subcontractor FOM**—Identifying and implementing corrective actions during field activities. Notifying the Project Manager and QA staff of conditions not immediately corrected.
- **DOE Prime Contractor Sample Management Office**—Identifying and implementing corrective action during analysis. Notifying the Project Manager and QA Specialist when applicable acceptance criteria or DQOs are not satisfied.

Immediate corrective actions will be noted in task notebooks. Problems not immediately corrected will require formal corrective action.

A.13. PREVENTATIVE MAINTENANCE

Periodic preventive maintenance is required for all sensitive equipment. Specific field equipment preventive maintenance practices and frequencies are described in the factory manual for each instrument.

Preventive maintenance procedures for laboratory equipment and instruments are provided in laboratory QA plans. All maintenance activities will be recorded in maintenance logs. Laboratories will be required to maintain an adequate inventory of spare parts and consumables to prevent downtime as a result of minor problems.

A.14. RECONCILIATION WITH USER REQUIREMENTS

The precision, accuracy, and completeness parameters are quantitative tools by which data sets can be evaluated. These parameters can help ensure that DQOs are met. Procedures for assessing them are provided in the following text.

A14.1 PRECISION

To determine the precision of the laboratory analysis, the laboratory performs a routine program of replicate analyses in accordance with the analytical method requirements. The results of replicate analyses are used to calculate the relative percent difference, which is used to assess laboratory precision.

For replicate results C_1 and C_2

$$\textit{Relative Percent Difference} = \frac{|C_1 - C_2| \times 100}{\frac{(C_1 + C_2)}{2}}$$

The precision of the total sampling and analytical measurement process will be assessed based on field duplicates. Although a quantitative goal cannot be set due to field variability, the Subcontractor will review field duplicate relative percent difference values to estimate precision.

A14.2 ACCURACY

To determine the accuracy of an analytical method and/or the laboratory analysis, a periodic program of sample spiking is conducted (minimum 1 spike and 1 spike duplicate per 20 samples). The results of sample spiking are used to calculate the QC parameter for accuracy evaluation, the percent recovery (% R).

For surrogate spikes and QC samples:

$$\% R = \frac{C_s}{C_t} \times 100$$

where

C_s = measured spiked sample concentration (or amount),
C_t = true spiked concentration (or amount).

For matrix spikes:

$$\% R = \frac{/C_s - C_o/}{C_t} \times 100$$

where
C_s = measured spiked sample concentration,
C_o = sample concentration (not spiked),
C_t = true concentration of the spike.

The accuracy of the total sampling and analytical measurement process will not be determined because such a determination would require the addition of chemical spiking compounds to the samples in the field.

A14.3 COMPLETENESS

To determine the completeness of data, the percentage of valid, viable data obtained from a measurement system is compared with the amount expected under normal conditions. The goal of completeness is to generate a sufficient amount of valid data to satisfy project needs.

Completeness (C) is calculated as follows:

$$\% C = \frac{\text{Number of valid measurements}}{\text{Number of total measurements}} \times 100$$

A.15. QA REPORTS TO MANAGEMENT

All levels of the Subcontractor's QA team are responsible for preparing QA reports, including the Monthly NCR Status Report.

The Subcontractor will submit a monthly activity report to the DOE Prime Contractor's STR, with a copy provided to the DOE Prime Contractor QA Specialist. Each report will summarize the following:

- NCRs issued during the reporting period,
- status of open NCRs during the reporting period,
- corrective actions initiated, and
- the status of corrective actions open during the reporting period.

A.16. FIELD CHANGES

Field changes must be governed and documented by control measures commensurate with those applied to the documentation of the original design, per the DOE procedure. A procedure for controlling field changes is discussed in the following text.

- Major changes from approved field operating procedures or project scope, cost, or schedule will be documented on a Field Change Request Form (FCR), similar to that shown in Fig. A.3. The FOM will initiate and maintain the FCR forms.

- Each FCR form requires the approval of the DOE Prime Contractor STR before work proceeds. Weekly quality status reports serve as the mechanism for notifying the QA staff of field changes. The DOE Prime Contractor QA Manager must approve changes related to quality and receive copies of field changes. Approval by the DOE Prime Contractor STR can be initiated verbally via telephone, with follow-up sign-off. In no case will a subcontractor initiate a field change. If a field change is proposed by the client, it will be so recorded. Copies of the FCR forms will be kept on-site until the fieldwork is complete and then will be transmitted to the project files.

- Variances or minor changes to field operating procedures will be documented in the field logbook and included in a variance log. The variance log will be used to track the type of variance and the logbook in which the variance was reported.

- If deemed necessary, the RDSI Characterization Plan, QAPP, ES&HP, or other relevant documents will be revised, reviewed, approved, and reissued with control measures commensurate with the original documents. The DOE Prime Contractor STR must approve each FCR form before work proceeds.

- Specific additional requirements for field changes such as required PGDP approvals would be addressed in contractual documentation between PGDP and its implementing subcontractor. The DOE Contractor QA Specialist must approve all field changes that impact the quality of the project before work proceeds.

Field Change Request (FCR)

FCR NO. ____________ DATE INITIATED ____________

PROJECT ____

CONTRACT NO. ______________________________________

REQUESTOR IDENTIFICATION

NAME ______________________ ORGANIZATION ______________ PHONE ______________

TITLE ______________________ SIGNATURE ______________________________

BASELINE IDENTIFICATION

BASELINE(S) AFFECTED ○ Cost ○ Scope ○ Milestone ○ Method of Accomplishment

AFFECTED DOCUMENT (TITLE, NUMBER AND SECTION) ______________________________

DESCRIPTION OF CHANGE:

JUSTIFICATION:

IMPACT OF NOT IMPLEMENTING REQUEST:

PARTICIPANTS AFFECTED BY IMPLEMENTING REQUEST:

COST ESTIMATE ($) ____________ ESTIMATOR SIGNATURE ______________________________

PHONE ______________________ DATE ______________

PREVIOUS FCR AFFECTED ○ YES ○ NO; IF YES, FCR NO. ______________

CLIENT PROJECT MANAGER ______________________________ DATE ______________

CLIENT QA SPECIALIST ______________________________ DATE ______________

SAIC H&S MANAGER SIGNATURE (IF APPLICABLE) ______________________________ DATE ______________

FTP-1220, Revision 0, 7/07/99

Fig. A.3. Example Field Change Request Form.

A.17. INSPECTION OF MATERIALS

All project materials (i.e., sampling instruments, health and safety instruments) will be inspected prior to acceptance and use according to a DOE Prime Contractor-approved procedure. The procedure for conducting material inspections is summarized in the text following text.

- Knowledgeable persons not directly responsible for the work being inspected will conduct inspections.
- The frequency of inspections will vary based on any contractual or regulatory requirements, past history, risk, complexity or importance of materials.
- Each scheduled inspection will be assigned an inspection number.
- Checklists will be prepared for work requiring inspections. Completed checklists will be attached to the Inspection Report and become part of the record of inspection.
- All inspections will be documented on an inspection report form, similar to that shown in Fig. A.4.
- All records generated from this procedure will be collected and maintained in accordance with a DOE Prime Contractor-approved procedure.
- The Task Leader will inspect all incoming shipments for apparent damage, shipping documentation discrepancies, and overages or shortages. For all discrepancies noted, the Task Leader will initiate an NCR in accordance with a DOE Prime Contractor-approved procedure.
- Each scheduled inspection will be assigned an inspection number.
- Checklists will be prepared for work requiring inspections. Completed checklists will be attached to the Inspection Report and become part of the record of inspection.
- All inspections will be documented on an inspection report form, similar to that shown in Fig. A.4.
- All records generated from this procedure will be collected and maintained in accordance with a DOE Prime Contractor-approved procedure.

The Task Leader will inspect all incoming shipments for apparent damage, shipping documentation discrepancies, and overages or shortages. For all discrepancies noted, the Task Leader will initiate an NCR in accordance with a DOE Prime Contractor-approved procedure.

INSPECTION REPORT

Date of Inspection: ______________________ Inspection No.: ________________

Project Name: ____

Location: ____

References (include Revision/Date): __________________________________

Activity / Item Inspected: ____

____

____

____

____

____

____

Personnel Contacted (include company, title , and phone #): _______________

____

____

Reference To Nonconformance Report(s): ______________________________

____

Results of Inspection: ____

____

____

____

Name (print)	Signature	Date

Fig. A.4. Example Inspection Report Form.

APPENDIX B

APPENDIX B

DATA MANAGEMENT IMPLEMENTATION PLAN

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ACRONYMS

COC	chain-of-custody
DMIP	Data Management Implementation Plan
DOE	U.S. Department of Energy
EDD	electronic data deliverable
GIS	geographic information system
MIP	Membrane Interface Probe
MW	monitoring well
Paducah OREIS	Paducah Oak Ridge Environmental Information System
Paducah PEMS	Paducah Project Environmental Measurements System
PARCC	precision, accuracy, representativeness, completeness, and comparability
PGDP	Paducah Gaseous Diffusion Plant
QA	quality assurance
QC	quality control
RTL	ready-to-load
SAS	Statistical Analysis System
SMO	Sample Management Office
SOW	statement of work
SQL	Structured Query Language
^{99}Tc	technetium-99
USEC	United States Enrichment Corporation
VOC	volatile organic compound

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B.1. INTRODUCTION

The purpose of this Data Management Implementation Plan (DMIP) is to identify and document data management requirements and applicable procedures, expected data types and flow, and roles and responsibilities for all data management activities associated with the C-400 Remedial Design Support Investigation (RDSI) at the Paducah Gaseous Diffusion Plant (PGDP). Data management provides a system for efficiently generating and maintaining technically and legally defensible data that provide the basis for making sound decisions regarding the environmental and waste characterization at PGDP.

To meet current regulatory requirements for the U.S. Department of Energy's (DOE's) environmental management projects, complete documentation of the information flow will be established. Each phase of the data management process (planning, collection, analysis, management, verification, assessment, reporting, consolidation, and archival) will be appropriately planned and documented. The RDSI subcontractor will conduct the data collection and data management for this project.

The scope of this DMIP is limited to the environmental and waste information to be generated as a result of the C-400 RDSI at PGDP. This information includes electronic and/or hard-copy records obtained by the project that describe environmental or waste processes or conditions. Information generated by the project (e.g., laboratory analytical results from samples collected) and obtained from sources outside the project (e.g., historical data) falls within the scope of this DMIP. Certain types of information, such as personnel or financial records, are outside the scope of this DMIP.

B1.1 PROJECT MISSION

This task will involve installation of Membrane Interface Probe (MIP) samples, soil borings for the collection of soil and groundwater samples, and waste sampling associated with the sampling effort in the vicinity of the C-400 Cleaning Building at PGDP.

B1.2 DATA MANAGEMENT ACTIVITIES

Data management for the C-400 RDSI will be implemented throughout the life cycle of environmental measurements data and historical data. This life cycle occurs from the planning of data for environmental and waste characterization, through the collection, review, and actual usage of the data for decision-making purposes to the long-term storage of data. Data management activities include the following:

- acquire existing data,
- plan data collection,
- prepare for field activities,
- collect field data,
- process field data,
- collect field samples,
- submit samples for analysis,
- process laboratory analytical data,
- verify data,
- coordinate data validation,

- assess data,
- consolidate, analyze, and use data and records, and
- submit data to the Paducah Oak Ridge Environmental Information System (Paducah OREIS).

B1.3 DATA MANAGEMENT INTERACTIONS

The DOE Prime Contractor Data Manager will interface with the RDSI subcontractor Data Coordinator to oversee the use of Paducah's Project Environmental Measurements System (Paducah PEMS) and to ensure that data deliverables meet DOE's standards. The DOE Prime Contractor Data Manager will enter information related to the fixed-base laboratory data packages and the tracking associated with the samples once the samples have been shipped from the laboratory and the DOE Prime Contractor Sample Manager has verified receipt of samples. The fixed-base laboratory hard-copy data; the electronic data deliverables (EDDs); and the field measurement data will be loaded into Paducah PEMS by the RDSI subcontractor Data Coordinator. The RDSI subcontractor is responsible for data verification and assessment and for preparing the data for transfer from Paducah PEMS to Paducah OREIS. The DOE Prime Contractor Data Manager is responsible for transferring the data from the ready-to-load (RTL) files supplied by the RDSI subcontractor to the Paducah OREIS database.

The DOE Prime Contractor Sample Manager will develop the statement of work (SOW) to be performed by an analytical laboratory in the form of a project-specific, laboratory SOW. Analytical methods, laboratory QC requirements, and deliverable requirements will be specified in this SOW. The DOE Prime Contractor Sample Manager will provide RDSI subcontractor with a matrix template. The RDSI subcontractor Data Coordinator will determine the sampling requirements and submit the completed and approved sampling matrix to the DOE Prime Contractor Sample Manager to assist in developing the laboratory SOW. The DOE Prime Contractor Sample Manager will receive EDDs, perform contractual screenings, and distribute data packages. The DOE Prime Contractor Sample Manager will interact with the RDSI subcontractor Data Coordinator to ensure that hard-copy and electronic-deliverable formats are properly specified and will interface with the contract laboratory to ensure that the requirements are understood and met.

B.2. DATA NEEDS AND SOURCES

Multiple data types will be generated and/or assessed during this project. These data types are historical data, field data, analytical data (including environmental data and waste data), and geographic information system (GIS) data.

B2.1 HISTORICAL DATA

Historical data consist of analytical data and lithologic descriptive data from borings and MWs previously installed in the project area.

Historical data available electronically, will be downloaded from Paducah OREIS, as needed. Historical data available in electronic format will be stored in the project's Paducah PEMS, should its evaluation be required. Historical data, available in hard-copy only, will be copied and catalogued in the project files, if required.

B2.2 FIELD DATA

Field data to be taken for the project include sample collection information and MIP results.

B2.3 ANALYTICAL DATA

Analytical data for the project are anticipated to consist of fixed-base laboratory analyses for waste characterization. These samples are expected to be taken from drummed waste. Laboratory analyses include the following.

- Volatile organic compounds (VOCs)
- Metals
- Radionuclides, including technetium-99 (^{99}Tc)
- Physical parameters

No mobile field laboratory analyses are planned for this project.

B2.4 GEOGRAPHIC INFORMATION SYSTEM COVERAGE

The Paducah GIS network will be used for preparing maps used in data analysis of both historical and newly generated data and reporting. Coverage anticipated for use during the project is as follows:

- Stations (station coordinates will be downloaded from Paducah OREIS)
- Facilities
- Plumes
- Plant roads
- Plant fences
- Streams
- Topographic contours

B.3. DATA FORMS/LOGBOOKS

Field logbooks, site logbooks, diskette logs, chain-of-custody (COC) forms, data packages with associated quality assurance/quality control (QA/QC) information, and field forms will be assigned document control numbers and maintained according to the requirement for a satellite document management center defined in the procedure for Paducah Records Management.

Duplicates of field records will be maintained until the completion of the project. The RDSI subcontractor Field Manager will copy logbooks and field documentation periodically. The originals will be forwarded to the project files; the copies will be maintained in the field trailer. The project file will be considered the Record Copy and, as such, will be stored in 1-hour-rated, fire-resistant, locked, file cabinets. Electronic versions also will be stored in the project file; the originator or the original recipient of the diskette will maintain back-up copies.

Records will be assigned a document number that will be consistent and recognized by the PGDP Document Management Center, as called out in the procedure for Paducah Records Management.

B3.1 FIELD COC FORMS

Field COC forms contain sample-specific information recorded during collection of the sample. Any deviations from the sampling plan will be noted on the field COC form. The Sample Team Leader will review each field COC form for accuracy and completeness as soon as practical following sample collection.

Field COC forms (Fig. B.1) will be generated from Paducah PEMS with the following information:

Information that is preprinted:	Information that is entered manually:
- COC number	- sample date and time
- project name or number	- top and bottom depths and units
- sample ID number	- sample comments (optional)
- sampling location (e.g., 001-001)	
-sample type (e.g., REG = regular sample)	
- sample matrix (e.g., SO = soil)	
- analysis (e.g., ^{99}TC)	
- sample container (volume, type)	

B.4. DATA AND DATA RECORDS TRANSMITTALS

B4.1 PADUCAH OREIS DATA TRANSMITTALS

Data to be stored in Paducah OREIS will be submitted to the DOE Prime Contractor Data Manager prior to reporting. RDSI data to be stored in Paducah OREIS include station coordinates for MIP borings and analytical data collected for waste characterization.

Official data reporting, as will be contained within the waste generation package or in other reports to outside agencies, will be generated from data stored in Paducah OREIS for any applicable data stored there.

B4.2 DATA RECORDS TRANSMITTALS

Upon completion of the project, the Site Investigation subcontractor Data Coordinator will forward original logbooks, field documentation, project deliverables, and Paducah PEMS to the PGDP Document Management Center. The project files will be submitted in standard records storage boxes, measuring 16 × 13 × 10 in. Each box will contain an index of the contents and appropriate Records Transmittal List and will be accompanied by a completed Material Transfer Form with a cover letter to the attention of the DOE Prime Contractor Records Manager. Environmental data will be archived by the DOE Prime Contractor Data Manager or designee.

Sample Chain of Custody Record

Page 1 of x

Remedial Design Support Investigation Characterization

Sample ID 1024567SA001

Date/Time Sampled

Project ID ERI06-400R-XXXX Sampler:__________

Station C400-M1

LAB COC NO.: COC # LAB CODE

Turnaround 30-Day Report Only

Chain of Custody

Sample Relinquished By __________ Date/Time __________

Received By __________ Date/Time __________

Sample Relinquished By __________ Date/Time __________

Received By __________ Date/Time __________

Sample Relinquished By __________ Date/Time __________

Received By __________ Date/Time __________

COC Relinquished By __________ Date/Time __________

Received By __________ Date/Time __________

PARAGROUP Matrix: SOIL

	Bottle: bottle description	Preservation	quantity
SOW Numbers: ERI06-xx:	VOA	LAB	

Method Name	Analyses

Miscellaneous:__________

U. S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
Bechtel Jacobs Company LLC

BECHTEL JACOBS COMPANY, LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

SAIC

Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

Fig. B.1. Paducah PEMS Chain of Custody.

FIGURE No. coc.ppt
DATE 06-28-01

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B.5. DATA MANAGEMENT SYSTEMS

B5.1 PADUCAH PEMS

Paducah PEMS is the data management system that supports the project's sampling and measurements collection activities and the generation of Paducah OREIS RTL files. Appropriate project staff can access Paducah PEMS throughout the life cycle of the project. The project will use Paducah PEMS for the following functions:

- initiate the project;
- plan for sampling;
- record sample collection and field measurements;
- record sample shipment to the laboratory (if applicable);
- receive and process analytical results;
- evaluate and verify data;
- analyze and access data;
- transfer project data (in RTL format) to Paducah OREIS; and
- store non-Paducah OREIS data (e.g., geophysical log results).

Paducah PEMS will be used for the project to manage field-generated data, import laboratory-generated data, update field and laboratory data based on data verification, and transfer data to Paducah OREIS. Requirements for addressing the day-to-day operations of Paducah PEMS include backups, security, and interfacing with the DOE Prime Contractor Data and Sample Managers.

The DOE Prime Contractor Network Administrator will perform system backups daily. Security of Paducah PEMS and of data generated during the project data management effort is essential for the success of the project. The security precautions and procedures implemented by the data management team will be designed to minimize the vulnerability of the data to unauthorized access or corruption. Only members of the data management team will have access to the project's Paducah PEMS, the hard-copy data files, and the diskettes and tape backups.

B5.2 PADUCAH OREIS

Paducah OREIS is the centralized, standardized, quality assured, and configuration-controlled data management system that is the long-term repository for environmental data (measurements and geographic) for all environmental management projects. Paducah OREIS is comprised of hardware, commercial software, customized integration software, an environmental measurements database, a geographic database, and associated documentation. The RDSI will use Paducah OREIS for the following functions:

- access to existing data,
- spatial analysis,
- report generation for waste disposal, and
- long-term storage of project data (as applicable).

B5.3 OAK RIDGE SAMPLE MANAGEMENT OFFICE TRACKER DATABASE

The Sample Management Office (SMO) Tracker database is the business management information system that manages analytical sample analyses for all environmental projects within the DOE-Oak Ridge Office. SMO Tracker supports the cradle-to-grave tracking of sampling and analysis activities, from the time a SOW is created on the database by the SMO Analytical Project Manager, through the selection of the laboratory, to the collection and shipping of samples, to the receipt of the analytical results, and finally to invoice reconciliation. SMO Tracker is integrated with Paducah PEMS (output from Tracker automatically goes to Paducah PEMS and vice versa).

B5.4 PADUCAH ANALYTICAL PROJECT TRACKING SYSTEM

The Paducah Analytical Project Tracking System is the business management information system that manages analytical sample analyses for all environmental projects within the Paducah Site. The Paducah Analytical Project Tracking System supplements SMO Tracker in cradle-to-grave tracking of sampling and analysis activities. The Paducah Analytical Project Tracking System generates the SOW, tracks collection and receipt of samples by the laboratory, flags availability of the analytical results, and allows invoice reconciliation. The Paducah Analytical Project Tracking System interfaces with Paducah PEMS (output from the Paducah Analytical Project Tracking System automatically goes to Paducah PEMS).

B.6. DATA MANAGEMENT TASKS AND ROLES AND RESPONSIBILITIES

B6.1 DATA MANAGEMENT TASKS

The following data management tasks are numbered and grouped according to the activities summarized in Sect. 1.2.

B6.1.1 Acquire Existing Data

The primary background data to be used for this project are geologic information contained in lithologic borehole descriptions and historical analytical data. Lithologic information required for this project is available only in hardcopy and is contained within several reports.

B6.1.2 Plan Data Collection

Additional documents for this project provide additional information for the tasks of project environmental data collection, including sampling and analysis planning, QA, waste management and disposition, and health and safety. A laboratory SOW will be developed with the DOE-Oak Ridge SMO following concurrence with the RDSI Waste Management and Disposition Plan.

B6.1.3 Prepare for Field Activities

Field preparation activities are performed to ready the site for field sampling operations. The data management tasks involved in field preparation include identifying all sampling locations and preparing descriptions of these stations, developing summaries of all the samples and analyses to be conducted at each sampling location, developing field forms for capturing field data, coordinating sample shipment/ delivery with off-site laboratories, and coordinating screening analyses with PGDP laboratories. These activities will be conducted by the RDSI subcontractor Data Coordinator working with the DOE Prime Contractor Sample Manager. Sampling locations will be surveyed upon completion of all temporary borings and any new MWs.

The RDSI subcontractor Field Manager and RDSI subcontractor Data Coordinator will coordinate data management activities with field sampling activities according to the procedure for Data Management Coordination.

The RDSI subcontractor Field Manager will review field forms for the collection of lithology and other sampling information for completeness. The field forms also will specify the appropriate type of information for each field. Copies of field forms will be numbered sequentially, and the number will be tracked in the field logbooks.

B6.1.4 Collect Field Data

Paducah PEMS will be used to identify, track, and monitor each sample and associated data from point of collection through final data reporting. The tracking system for the project will include field logbooks, field forms, COC records, and hard-copy data packages as well as EDDs.

Data management requirements for field logbooks and field forms specify that (1) sampling documentation must be controlled from preparation and initiation to completion, (2) all sampling documents generated must be maintained in a project file, and (3) modifications to planned activities and deviations from procedures shall be recorded. Field data documentation shall be maintained according to satellite document management center requirements outlined in the procedure for Paducah Records Management.

The comprehensive sampling list developed by the RDSI subcontractor Field Manager and RDSI subcontractor Data Coordinator is used as the basis for finalizing the sample containers to be used for sample collection, ordering sufficient amount of containers and other supplies, and verifying the numbers of samples presented in the laboratory SOW. Before the start of field sampling, the RDSI subcontractor Data Coordinator will specify the contents of sample kits, which will include sample containers, labels, preservatives, COC records, and instructions for collecting samples. Samples labels will be completed according to procedures stated in the RDSI Characterization Plan.

B6.1.5 Process Field Data

Field measurements will be recorded on appropriate field forms or in field data compilers. These forms will be checked against the field logbooks, and the data will be manually entered into Paducah PEMS using the procedure for Data Entry, as necessary. Paducah PEMS will not store MIP readings.

B6.1.6 Collect Field Samples

The field team will collect samples for the project. The field team will record pertinent sampling information on the COC, along with maintaining a field logbook. The RDSI subcontractor Data Coordinator according to the procedure will enter information from the COC forms and field forms manually into Paducah PEMS for Data Entry.

B6.1.7 Submit Samples for Analysis

Samples will be submitted for fixed-base analysis for waste characterization. Before the start of waste characterization sampling, the RDSI subcontractor Field Manager and RDSI subcontractor Data Coordinator will coordinate the delivery of samples and the receipt of results with the DOE Prime Contractor Sample Manager who, in turn, will coordinate with the contract fixed-base laboratories. The RDSI subcontractor Data Coordinator and DOE Prime Contractor Sample Manager will present a general sampling schedule to the fixed-base laboratories. The RDSI subcontractor Data Coordinator also will coordinate the receipt of sample shipments and containers with the laboratories and determine any requirements for laboratory permission to ship. The DOE Prime Contractor Sample Manager will ensure that hard-copy deliverables and EDDs from the laboratories contain the appropriate information and are in the correct formats.

B6.1.8 Process Laboratory Analytical Data

Data packages and EDDs received from the laboratory will be tracked, reviewed, and maintained in a secure environment. Paducah PEMS will be used for tracking project-generated data. The primary individual responsible for these tasks will be the DOE Prime Contractor Sample Manager. The following information will be tracked, as applicable: sample delivery group number, date received, number of samples, sample analyses, receipt of EDD, and comments. The DOE Prime Contractor Sample Manager will compare the contents of the data package with the COC form and identify discrepancies. Discrepancies will be reported immediately to the laboratory and the RDSI subcontractor Data Coordinator. Copies of the Form I's from the data package will be distributed to the RDSI subcontractor Data Coordinator.

To evaluate the quality of laboratory EDDs, the first two EDDs from each laboratory will be 100% checked against the hard-copy data packages. After the first two EDDS from each laboratory are checked, every fifth EDD will be 100% checked. The results from the EDD will be checked, as will the format of all fields provided. The RDSI subcontractor Data Coordinator will report immediately any discrepancies to the DOE Prime Contractor Sample Manager so that the laboratory can be notified and EDDs can be corrected.

B6.1.9 Verify Data

The RDSI subcontractor Data Coordinator is responsible for ensuring that data verification occurs as outlined in the procedure for Quality Assured Data. Data verification processes for laboratory data will be implemented for both hard-copy data and EDDs. The data packages will be reviewed to ensure that all samples receive the analyses requested. Discrepancies will be reported to the laboratory. Electronic data verification of the EDDs will be performed as data are loaded into Paducah PEMS. The hard copy will be checked to ensure that requested parameters, indeed, were analyzed for; those missing from the EDD will be requested from the laboratory. Integrity checks in Paducah PEMS also will review the results generated by the laboratory to ensure that data for all requested parameters have been provided. Discrepancies will be reported to the DOE Prime Contractor Sample Manager.

B6.1.10 Validate Data

The RDSI subcontractor Data Coordinator is responsible for coordinating data validation. Data validation will be performed on 100% of the data package for 5% of the data packages received. RDSI subcontractor validators not associated with the project will perform validation, following their procedures for data validation.

B6.1.11 Assess Data

Data assessment will be conducted and documented according to the procedure for Quality Assured Data. The data review process determines whether a set of data satisfies the data requirements defined in the project-scoping phase. This process involves the integration and evaluation of all information associated with a result. Data review consists of an evaluation of the following: data authenticity; data integrity; data usability; outliers; and precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. Additional requirements for data assessment and review are included in Appendix A.

B6.1.12 Consolidate, Analyze, and Use Data and Records

The data consolidation process consists of the activities necessary to prepare the evaluated data for the users. The main users of the project data are the project team, which uses the data to document the installation of the temporary borings, to document and interpret the MIP data from the soil and groundwater samples, and to characterize the project waste before disposal. The DOE Prime Contractor Data Manager will store the fixed-base analytical and location data in the Paducah OREIS database for future use.

Project reports are reports generated for the purpose of evaluating the data during the project. These reports include the status of the sampling event, reports of data compared to various criteria such as grain size at various depths, and reports of the complete set of data. Data analysis will be documented in sufficient detail to allow re-creation of the analysis. Project reports, as defined previously, may be generated from PEMS. Official data reporting, as will be contained within the Remedial Action Work Plan or in reports to outside agencies, will be generated from data stored in Paducah OREIS, as applicable.

B6.1.13 Submit Data to the Paducah OREIS

Upon completion of the data assessment, Paducah PEMS will be used to generate the RTL file for Paducah OREIS.

B6.2 DATA MANAGEMENT ROLES AND RESPONSIBILITIES

The following project roles are defined, and the responsibilities are summarized, for each data management task described in the previous subsection.

B6.2.1 RDSI Subcontractor Project Manager

The RDSI subcontractor Project Manager has responsibility for completing the project. The RDSI subcontractor Project Manager leads the effort to define the scope of the data management, which involves directing the project team in determining potential sources of existing data, identifying the study area to be addressed by the project, and selecting the most effective data collection approach to pursue. The RDSI subcontractor Project Manager also may be the technical contact for subcontracted project support and should ensure that the flow down of data management requirements is defined in a SOW.

B6.2.2 Project Team

The project team consists of the technical staff and support staff (including the data management team) that conduct the various tasks required to successfully complete the project. Team members develop a conceptual model of the project site. Based on this model, they determine if more information is needed to make decisions about the site. If more sampling and analyses are needed, the team develops a work plan to acquire that information. This team provides information needed by the decision makers (i.e., stakeholders). The project team also consists of those individuals who perform any activities taking place in the field (e.g., inspections, geophysical logging, drilling, sampling). They will be responsible for recording field activities in field logs and data sheets.

B6.2.3 Data User

Data users are members of the project team who require access to project information to perform reviews, analyses, or ad hoc queries of the data. The data user determines project data usability by comparing the data against predefined acceptance criteria and assessing that the data are sufficient for the intended use. This person performs data reviews, as appropriate (e.g., quality checks, assessing PARCC parameter conformance, and evaluating adherence to data quality requirements).

The data user also will be responsible for retaining any unique computer code (e.g., Structured Query Language [SQL] code, Statistical Analysis System [SAS] code, GIS coverage) used to generate data products (e.g., tables, graphs, maps) included in project reports. This requirement ensures that data products can be reproduced in the future.

B6.2.4 RDSI Subcontractor Data Coordinator

The RDSI subcontractor Data Coordinator is the project's single point-of-contact for interaction with other organizations and programs regarding project data management (e.g., Paducah PEMS and Paducah OREIS). The RDSI subcontractor Data Coordinator has the responsibility for developing and implementing the project DMIP to ensure that project data management requirements are met. The RDSI subcontractor Data Coordinator ensures that any existing data or new project data are properly incorporated into the project's hard-copy data record file or database, as appropriate, and ensures that the project data are properly incorporated into Paducah OREIS, as applicable. The RDSI subcontractor Data Coordinator must ensure that hard-copy data records are processed according to project data records management requirements as stated in the procedure for Paducah Records Management. The RDSI subcontractor Data Coordinator also interacts with the DOE Prime Contractor Sample and Data Managers and is responsible for identifying and obtaining data management training for the project team.

The RDSI subcontractor Data Coordinator also is responsible for overseeing activities of the rest of the project data management team. The project data management team is responsible for entering project information into the project data records file and/or database and ensuring that all information has been entered correctly. The data management team works with field teams to facilitate data collection and verification and with data users to ensure easy access to the data.

B6.2.5 DOE Prime Contractor Document Center Manager

The DOE Prime Contractor Document Center Manager will be responsible for the long-term storage of project records. He or she will interface with the RDSI subcontractor Data Coordinator to ensure that document and record transmittals meet DOE's standards.

B6.2.6 RDSI Subcontractor QA Reviewer

An RDSI subcontractor QA Reviewer will be part of this team and is responsible for reviewing field logs to determine if the project team followed all applicable procedures. The RDSI subcontractor QA Reviewer ensures that all samples were properly labeled, instruments were calibrated prior to taking measurements, and information was recorded correctly.